PRODUCT ENGINEERING

NOVEMBER
1934

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New products for new industries, new machines that obsolete the old, new forms and colors that inspire the demand for the better and more beautiful—thus are product engineers furnishing the final impulse that spells prosperity

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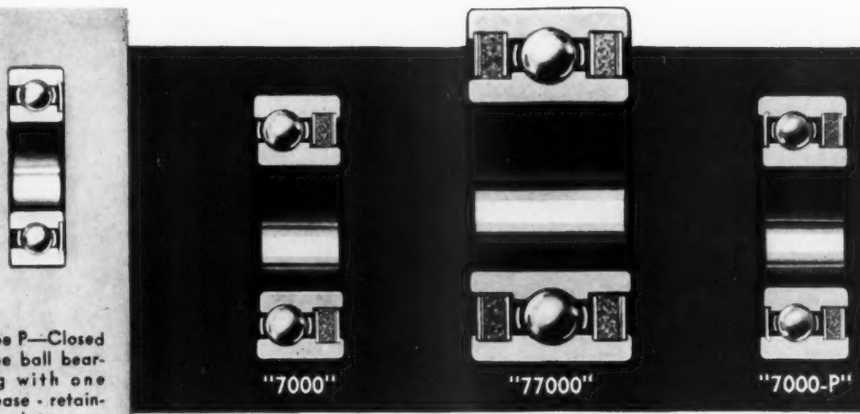
The 1934 Product Development Survey

McGRAW-HILL PUBLISHING COMPANY, INC.



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Out of their experience of more than 23 years, NORMA-HOFFMANN engineers — pioneers in the design of enclosed and self-protected bearings —have developed and patented a range of types which meets practically every bearing condition and which affords the mechanical world

The Most Complete Line of SELF-PROTECTED BEARINGS in America

The "GREASEAL" Series of Felt-Protected Ball Bearings—in the three types illustrated above—is marked by the following outstanding features which make for better performance and more lasting satisfaction:- thick, closely-fitting felts between removable plates forming an effective labyrinth against the recessed inner ring - - - FELT SEAL REMOVABLE in its entirety for inspection, cleaning or renewal of grease - - - wide, solid inner and outer rings, with maximum contact on shaft and housing, make inserts in housing unnecessary and militate against slippage, looseness, and escape of lubricant past outer ring - - - felt seal within confines of both rings and not exposed to injury - - - constructional characteristics assuring dimensional exactness and quiet running - - - grease capacity ample for long periods of service. . . . . Eight other types of Self-Protected PRECISION Bearings are here pictured and indexed. Write for the complete Catalog. Let our engineers aid you in selection and application.

NORMA-HOFFMANN BEARINGS CORPN.

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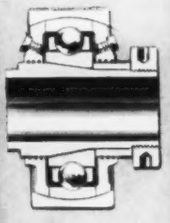
Type P—Closed type ball bearing with one grease - retaining plate.

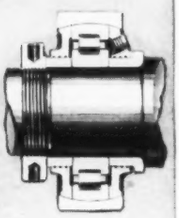
Type PP — closed type ball bearing with two grease - retaining plates.

Type GS — "Greaseal" felt - protected, grease - packed ball bearing.

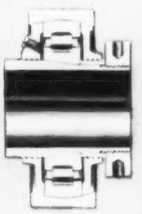
Type EGS — Adjustable, felt - protected, grease - packed ball bearing.



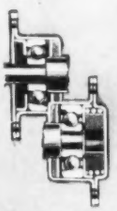
Type LTW — Self - aligning ball bearing with swiveling grease - retaining side plates and adapter sleeve.



Type RLSW — Self - aligning roller bearing with swiveling grease - retaining side plates.



Type RLTW — Self - aligning roller bearing with swiveling grease - retaining side plates and adapter sleeve.



CUP MOUNTING — Designed to use with small open type ball bearings in high-speed devices; furnished as complete units.

"NORMA-HOFFMANN"

PRECISION BEARINGS

BALL, ROLLER AND THRUST

PRODUCT ENGINEERING

VOLUME 5 NUMBER 11

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W. E. KENNEDY, *Manager*

Coming Issue

In the December number we start a series of articles on the design of metal stampings, by J. K. Olsen, well known to our readers for his previous articles on this subject. Other articles in December will include the graphical solution of problems in the design of bearings, by Victor Tatarinoff; one on cast iron by J. M. Lessells; and one on the design of optical systems, by R. C. Hitchcock.

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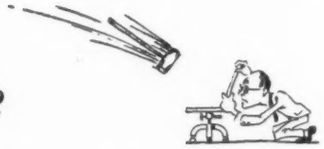
Intimate Correspondence



Omission

PRODUCT ENGINEERING
NEW YORK

I hope your campaign for renewed subscriptions to *Product Engineering* was a great success because of your promise to continue the Design Work Sheets. However, in July and August they were called Reference Book Sheets, in September there were none, in October some very incoherently connected ones incomplete in themselves.

Can I expect better editing in the future? Kindly advise me.

P. H. BERGGREN
Detroit

A WORD of explanation and apology is certainly due Mr. Berggren, and other readers who may have felt as he did but did not tell us about it. The Design Work Sheets are selected from published Reference Book Sheets and printed in book form for use as a premium for subscription renewals. They differ only in name.

Mr. Berggren's copy of the September number may have been defective for there certainly were two sheets in that number. As for October we can only offer an apology for the fact that one article came in two weeks late and would not fit the space left for it. There was nothing to do but jettison the Reference Book Sheets in order to make room. We promise not to let it happen again.

An Investment

PRODUCT ENGINEERING
NEW YORK

That burning sensation of your ears a few days ago was simultaneous with the arrival of my copy of the October number of *Product Engineering*. I am an inveterate filer of engineering "literature," and have found that filing is most convenient when the title of the article is on the left-hand page of a leaf. And when the title page and the next page face, it still is not so bad because the two leaves can be pasted together with the title page outside and on the left. But a heinous thing is two or more articles, on different subjects, running together so as to necessitate their being filed together.

Now, along comes the October number of P. E. and what do I find? Beginning on page 379 and ending on page 385 are three articles I must file together; and to add to the confusion, the first article is continued on pages 398 to 400! Ah's regusted!

You departed from your regular system, however, in two cases. On page 375 and 376, and pages 377 and 378 are two articles that are ideal for filing. What was wrong, did something go haywire? To be consistent you should have begun the first article on the right-hand page of the first leaf and the second article on the right-hand page of the second leaf, then it would have been necessary to file them together. In fact, by closer attention you might arrange the articles so that in case filing of them all is desirable, it would be necessary to file the entire magazine in one folder.

Technical magazines bring us live, up-to-date information; and for maximum benefit the articles of immediate or likely future interest should be saved. Textbooks and handbooks are, of course, indispensable, but naturally they cannot serve the purpose of current articles on recent developments. So filing seems to be a factor in the life of the technical man who wishes to be abreast of the times. And the publisher could be a friend indeed by arranging the articles so as to meet the requirements hinted in the foregoing.

I have for many years been on the verge of pleading with publishers to have a thought for the reader who has found filing profitable; but it took this last issue of P. E. with its goshawful arrangement to detonate that accumulated charge.

Life seems to be a melange of brickbats and bouquets, with the brickbats predominating. Having dispensed the brickbat I shall offer a bouquet by the simple statement that in its few years of existence P. E. has contributed to my files a greatly disproportionate share of valuable articles—and I consider technical magazines an investment, or a tool, rather than an expense.

C. O. SANDSTROM
Los Angeles

THE explanation for the previous complaint goes for this one too, and so does the apology. What we particularly like about Mr. Sandstrom's letter is his estimate of *Product Engineering* as an investment, a working tool for the engineer.

Profit

PRODUCT ENGINEERING
NEW YORK

As a subscriber to your paper I secure considerable information and profit from reading the very high class material in your magazine, your compiling various elements that are needful for not only executives but men all the way down to the drafting board. I sincerely hope you keep up the showing of these newer designs which I am very happy to note that you are featuring in your magazine.

E. W. H. RENNICK
Fort Wayne

REST assured that we shall continue the descriptions of new designs. They are the tangible evidence of the work done behind the scenes by the designers and product engineers. They are the news of this field and they should provide inspiration to every product designer.

Advertisers Please Note

PRODUCT ENGINEERING
NEW YORK

About a year or more ago, we saw in your columns a write-up and also advertising on a push button switch which operated on a button movement of only a couple thousandths of an inch. We have tried to find this material again in the old files but have been unable to locate it. Can you help us by sending us the manufacturer's name and address?

L. J. RADERMACHER
Milwaukee

PRODUCT ENGINEERING
NEW YORK

In the September issue, page 346 (and also in some former issues) there is a short article about high speed step-up friction drives.

Could you advice me who manufactures drives of this kind, or where I might get additional information about them? It may help me to find the answer to a very troublesome problem.

E. L. WHELESS
Shreveport

WE HAVE included these two letters because they give us a chance to talk to advertisers. It is easy enough for us to answer such letters but it should not be necessary. Products such as the ones mentioned should be advertised continuously in *Product Engineering*. When an engineer needs information about such items he needs it at once, and he should not have to take the time to write in to us for it and wait for a reply. The field of *Product Engineering* is a live one as will be entirely obvious from a study of the Product Development Survey to which this issue is devoted. The value of advertising to such a field should be equally obvious.

Sample Copy

PRODUCT ENGINEERING
NEW YORK

Mr. Wm. Zeh, Secretary and Treasurer of the Zeh & Hahnemann Co. of Newark, N. J., 182 Vanderpool Ave., will be very much interested in the article on the Extrusion of Aluminum by Mr. Hall. If that company is not a subscriber, kindly send them a sample copy, attention of Mr. Wm. Zeh.

L. HERES DE WYK

HERE is a suggestion that we are glad to pass on to other readers who may find it appropriate. We can of course find enough sample copies to supply your friends or business associates whom you think will be interested in articles that have appeared in *Product Engineering*.

PRODUCT ENGINEERING

KENNETH H. CONDIT, *Editor*

MCGRAW-HILL PUBLISHING CO., INC. NOVEMBER 1934 VOLUME FIVE, NUMBER ELEVEN

You Can't Plow Under New Ideas

REPEATEDLY history has shown the futility of attempting to control or stop mental processes or to stifle ingenuity. Kings, emperors and dictators, parliaments, congresses and cabinets have failed in every attempt to stay the flow of ideas and the resulting material developments. Even popular opposition to new ideas and inventions has but served to advertise them and foster their growth.

The first automobiles were legislated off the streets of Detroit, mobs stoned Cartwright's cottage because of his successful development of the loom, Fulton's venture was dubbed a folly, and Faraday's discovery of electricity was labeled a useless toy.

But even more significant is that which occurs when wars, catastrophes or business depressions grip the country. Then the minds of men become pitched to their highest degree of intensive planning, scheming and dreaming. The moment some disaster takes place thousands of ideas are born to provide some means or other to prevent a recurrence. Double-bottomed ships and water tight bulkheads were conceived because of marine disasters, automatic block signals grew out of railroad wrecks, and the innumerable safety and control devices on machinery were developed in response to the demand for fewer crushed limbs and not so many sacrificed lives.

Wars bring forth new weapons of offense and defense, and remarkable advances in medicine and surgery. A disaster furthers new inventions in the particular field in which it happened. But there is one social condition that will foster tremendous development in *all* fields of human activity.

When the machinery of civilization gets out of gear and for some cause or other trade and commerce drop to a low ebb, thoughts turn to ways and means of stimulating business. Bankers strive to modify the machinery of credit to accommodate the new conditions, while politicians and legislators propose and enact man-made laws in a vain attempt to circumvent those of nature.

Admittedly, government action can dictate working hours, establish minimum wages and fix prices. Executive authority can compel the slaughter of millions of pigs and cattle or the plowing under of acres of cotton or wheat. But neither the edict of a dictator nor the acts of legislatures can stop the mind of man from functioning nor the fruits thereof from seeing the light of day. You can subject physical acts to dictatorial power—but you can't plow under new ideas.

THROUGHOUT the whole of this depression scientists and engineers have been bending every effort to the creation of new and improved products. They have brought new industries into existence—they have conceived more efficient designs that have obsoleted equipment and machinery and they have created new forms and colors that have developed tastes for the better and the more beautiful. Thus will be captured the dollars to be turned back into the channels of trade.

Photograph by F. S. Lincoln

We Survey t

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In admiration and wonder we behold the new and seek in its beauty and excellence the solutions to the problems that are ours

•

WHEN one contemplates the new products that have come on the market during the past year, and studies the development work that is going on right now, it is impossible to escape the conviction that the whole philosophy of engineering design is undergoing a complete revision. The old and timeworn principle of resorting to the cheapest to get lowest-cost good-enough products has been supplanted by the axiom of engineered economy that achieves highest-quality products as measured by modern standards of perfection—products that, because of their sales appeal, are marketable at profit prices.

Never before have salesmen and vendors been given as big a dollar value to sell. In answer to frantic demands for products that would pull open the purse strings of possible purchasers, product engineers have established a new conception of engineered perfection. This engineering philosophy demands that materials be selected primarily on the basis of their ability to meet the service requirements, it calls for the adding of parts and devices for more convenient and improved operation, and the creation of a form and finish that intensifies sales appeal. And all this to be accomplished with little or no increase in cost of the finished manufactured products.

Herein lies the yardstick of engineering ability. The honors as measured in sales records go to those product engineers who are most adept in availing themselves of the best materials, parts and finishes for the purpose and using them in the most economical manner. Thus, the economics of welding, stampings, drawn or extruded sections, diecastings, molded parts and similar constructions have paved the way for using better materials and applying the savings to further improvements.

Results that reflect the tremendous efforts put forth to develop products of the highest quality and salable at prevailing prices are pictured and described in the pages that follow. For the data and information presented here questionnaires were sent to the chief engineers and executives of leading companies in various fields of manufacture. Added to this source of information were hundreds of letters, and visits by the

ey the Results

of Engineering Activity

How improved parts, materials, processes and finishes are being applied and how, by skillful design, new, better and more economical products have been created, as revealed by this 1934 Product Engineering Survey

Courtesy Ludlum Steel Company

From the furnaces of industry come new metals, new alloys—the materials for modern design

editors. We also wish to acknowledge the assistance rendered by Herbert Chase, consulting engineer, and T. J. Maloney, marketing councilor, in gathering this information. All told, the data and information presented here was derived from more than 1,000 sources.

Special attention was given to determine the reasons for the use of various materials and parts. Wherever seeming discrepancies or contradictions were encountered further information was requested and invariably received. These designers and many others have made this presentation possible, and we regret that space does not permit a more complete presentation of the experiences of those who contributed to this report.

One feature of this survey, common to all products shown, is the evident aim of product engineers to avail themselves of the new and improved parts, materials and finishes. Thus, beryllium copper, alloy cast irons and steels, magnesium alloys, laminated metals and hard facing materials are only a few of the numerous materials the use of which has increased remarkably over the past few years.

Similarly, parts and finishes such as sealed-in anti-friction bearings, oilless bushings, variable speed transmissions, magnetic clutches, automatic controls and built-in lighting equipment have witnessed a striking increase in number of applications, while paints, lacquers, plating and porcelain enamel are considered indispensable.

Another highly significant fact is revealed by the relative number of men engaged in design, research and product development. Compared with the previous year, there has been an increase of 15.5 per cent. At the same time, the index of business activity as compiled by the *Business Week* shows a slight drop. One can only conclude that encouraged by the period of

business improvement of about a year ago manufacturers decided that the time was opportune to put forth every effort in developing new lines of products and redesigning old ones. This is evidenced by the great number of new products portrayed here and the complete redesign of whole lines of products of different manufacture.

That manufacturers have been wise in expanding their product development activities is substantiated by many recent events. One of the largest merchandising companies has placed an initial order for 150,000 electric refrigerators of a new design. Machine tool sales are on the increase, likewise food processing and packaging machinery, construction machinery and equipment and electrical machinery for the home.

Typical of many letters reporting profits from increased product development, Ogden S. Sells, vice-president and general sales manager of the Food Machinery Corporation wrote:

"While we reduced somewhat our engineering and research personnel during the depression in 1931, 1932 and 1933, our various divisions carried on intensive development work with the result that in 1934 we doubled our 1932 and 1933 sales volume and nearly equalled our 1931 volume.

"Between 75 and 80 per cent of our volume has come from machinery items which either were non-existent in 1930 or which we changed so materially as to constitute invention. Or to state it differently, had we been forced to sell our 1931 line, our 1934 volume would have been one-half of our 1933 volume."

Meeting strength requirements is the most common problem in mechanical design. One of the significant facts disclosed by this survey is that 22 per cent of the companies represented in the survey report recent or expected adoption of alloy cast iron for high strength. This is not surprising when one considers that cast iron is still the most widely used material of construction and it is but natural that full advantage be taken of its improvement. The following tabulation gives the reasons for the adoption of cast iron alloys in the various fields of mechanical products.

Why Alloy Cast Irons Are Being Used

Percentages based on number in each group listed

FIELD OF MANUFACTURE	High Strength	Wear	Corrosion Resistance
	(Per cent of companies reporting)		
Construction & Mining Machinery	41	27	7
Engines and Pumps	40	42	30
Production Machinery	33	27	4
Speed Reducers, Coupling, Clutches, etc	30	30	..
Packaging Machinery	20	7	..
Total for all companies	22	18	7

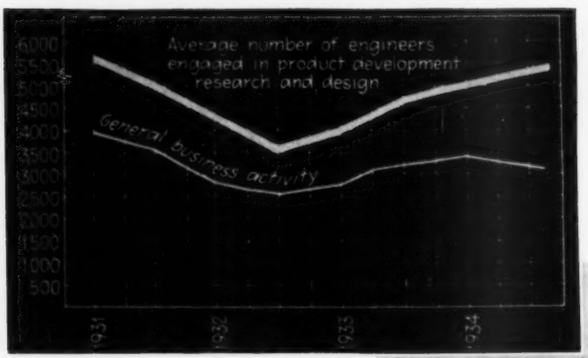
Where strength is the primary requirement and light weight is secondary, the alloy steels are favored; but in the selection of the particular type of alloy steel, engineers consider the other requirements to be met. The following tabulation shows the relative preference for the various types of steels to meet specific requirements.

Alloy Steels for Various Requirements

Percentages based on all companies included in survey

TYPE OF ALLOY STEEL	High Strength	Fatigue Resistance	Impact Strength	Wear Resistance
	(Per cent of companies reporting)			
Nickel Steels	12	7	3	6
Chrome-Nickel	13	6	3	6
Chrome-Moly	9	5	4	5
Chrome-Vana	5	3	1	2
Moly-Nickel	4	2	2	9
Vana-Nickel	1	1	..	..

Based on the total number of reporting companies, the adoption or expected adoptions of the various alloy steels, are as follows: Nickel steels, 18 per cent; chrome-



The business index is lower but more product engineers are being employed

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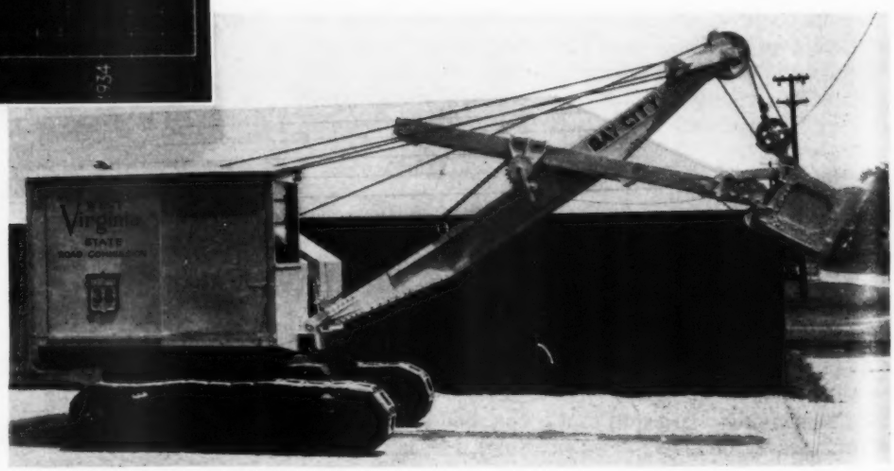
The trucks and upper revolving tables in Bay City shovels are of nickel-manganese steel castings, heat-treated for strength



nickel steels, 23 per cent; chrome-molybdenum steels, 13 per cent; chrome-vanadium, 6 per cent; moly-nickel, 7 per cent; vanadium-nickel, 2 per cent. These figures are only relative since a considerable number of the companies included in this report manufacture products such as instruments and household equipment, wherein strength requirements do not predominate. Exclusive of these, the figures are about three times higher.

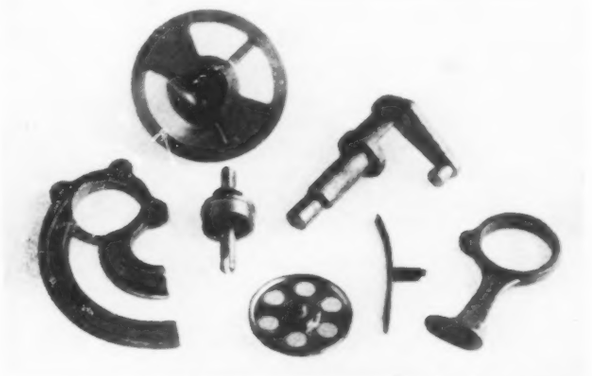
It is also to be noted that where strength at elevated temperatures is involved, the chrome-nickel steels are favored over moly-nickel steels in the ratio of almost three to one. This is surprising in view of the fact that chromium, according to reported investigations, increases resistance to corrosion but adds nothing to creep strength, whereas molybdenum has a pronounced effect in increasing the creep strength at elevated temperatures. This seems to indicate a lack of understanding among designers of the effect of various alloying elements at temperatures above normal.

For High Stresses and Impact

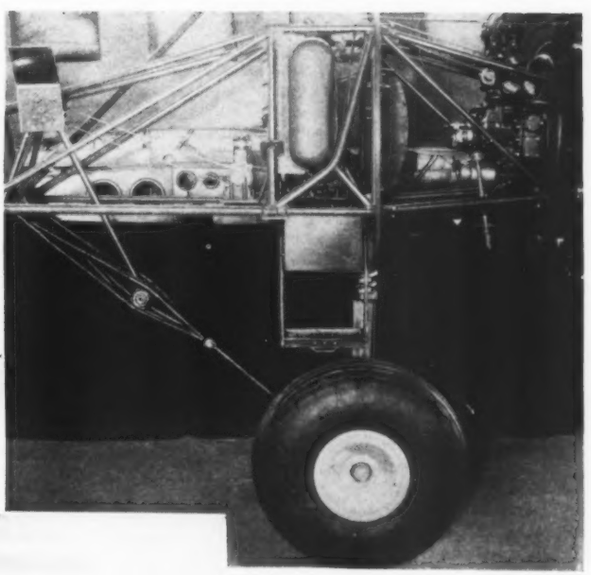
For impact resistance, chrome-moly is being selected in the greatest number of instances. Also, where high stresses at normal temperatures are the primary consideration, the chrome-moly and nickel-moly steels are favored. For example, in the design of airplanes, chrome-moly seamless tubing is used for landing gears and also for framing, engine mounts and similar highly stressed parts.

Although not included as one of the items on the questionnaire, the new chromium-manganese-silicon alloys are rapidly becoming popular because of their combination of strength, toughness and wear resistance. Extensive use of this alloy was made in the design of

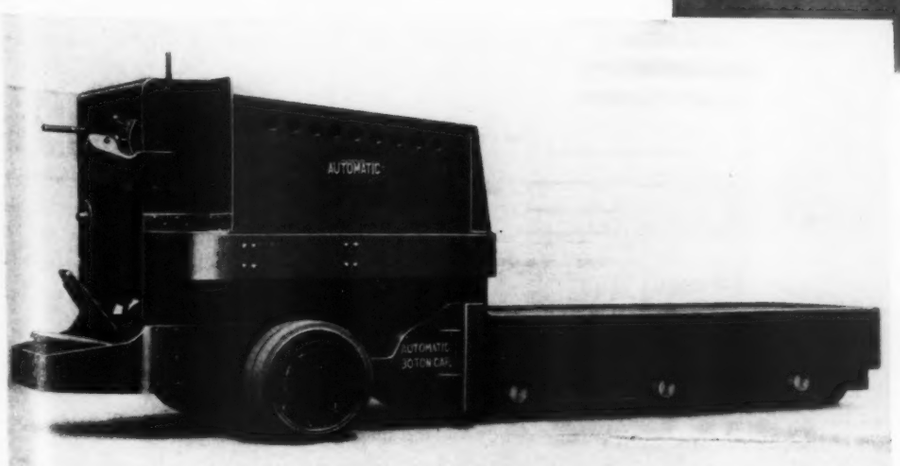
High strength parts for household equipment, milk-bottling machines and automotive hardware die-cast from aluminum bronze by Aurora Metal Co.



Inserts of phosphor bronze (left) and steel (below) in these two aluminum bronze die-castings simplify design and reduce cost



Motor operated retractable landing gear of welded chrome-moly seamless tubing on the Curtiss-Wright Condor transport planes



In the 30-ton Automatic truck, gears on the lift unit and drive axle are of heat-treated nickel-chrome steel

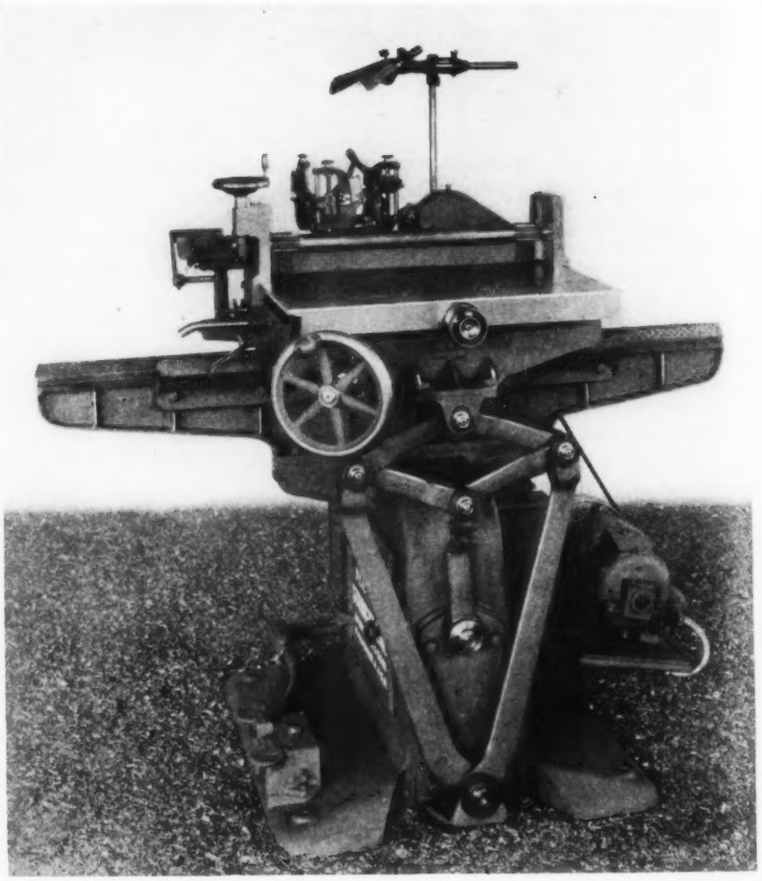
the yacht *Rainbow,* America's cup defender. This alloy, marketed under the tradename Cromansil, is also being used for welded machine-tool frames, power presses, hydraulic presses and machinery foundations. Engine beds and bases on a number of the new light high-speed trains are made of this material.

Nickel steel in place of carbon steel for large propeller shafts, is now favored by one of the leading ship builders. One press manufacturer uses chrome-moly for connecting rods, and cast steel for flywheels to permit higher speeds. In textile machinery, steel drop forgings are being used to obtain higher strength. Numerous other specific applications wherein alloy steels have supplanted plain carbon, could be cited.

However, it must not be concluded that high alloy steels are the only answer to the high strength problem. Quoting H. G. Marsh of the Carnegie Steel Company:

"The trend toward light-weight construction in many lines has created a market for high tensile steels which can be produced at a relatively low cost and compete with other light-weight materials. To meet this demand, we have arranged to produce a series of steels that enable the designer to increase the working stresses and materially reduce the weight of construction. Some of them, also, have high corrosion-resisting qualities which make them very desirable. They have been used in the construction of freight cars, the new Presidents' Conference (street railway) Car, machine tools, presses and machinery of all kinds.

"Another development which is of importance to all manufacturers who require a uniform steel for heat-treating or carburizing purposes, is the Controlled Steels. In these carbon steels, all of the quality factors, including austenitic grain size, are under such close metallurgical control that once the proper type of steel is determined for a given part, it is possible to manufacture heat after heat of this steel by the open hearth process with a regularity which was hitherto possible only by other more costly methods of manufacture. This permits the safe use of steels of wider ranges and higher contents of carbon and other hardening elements, and greater latitude in heat-treatment, with resultant economy and efficiency. Such steels are finding a wide application in the manufacture of automotive parts, railroad equipment, oil well equipment, machine parts, and tools of all kinds."



Light-weight magnesium alloy for the table frame casting makes the Royle beveller much easier to operate

Corrosion Resistance

For applications requiring both strength and corrosion resistance, stainless steels and aluminum alloys are receiving most attention, respectively 14 per cent and 7 per cent of the reporting companies having adopted or are contemplating the adoption of these materials for those purposes. Other materials that are being favored primarily for their corrosion resistance include copper, copper-nickel alloys, beryllium copper, bronze, pure nickel, chrome-nickel alloys, rubber and vulcanized fiber.

Where a combination of strength and corrosion resistance is required, and die cast construction is desired, aluminum bronzes are favored. These alloys are also favored for their wear resistance. Aluminum bronze worms die cast on a ground steel shaft needing no subsequent machining, pump impellers, drain valves for dish washers, oil valves, bottle capping machine parts and automotive hardware, are a few of the applications reported by 12 per cent of all the manufacturers included in this survey.

In using nickel and stainless steels, special attention is being given to the use of the clad sheets in order to procure the desired corrosion resistance at a greatly lower cost. Stainless clad now available in thicknesses ranging from 20 gage to 2 in., 20 per cent of the thickness being stainless steel bonded to a mild steel plate.

Improvements in welding procedure now make it easy to weld clad sheets without altering the corrosion resistance of the finished part.

Stainless clad is finding many applications for dairy equipment, food machinery, tanks for corrosive liquids, truck tanks and scales. One specific application is for use as an outer shell, solely for appearance.

Apparently improvements in the metallurgy of stain-

less steels and the greater experience of manufacturers in handling it is opening up further fields for its application. This refers primarily to the ability to draw the sheets which has resulted in its use for electric refrigerator coolers and other parts requiring drawing operations. Similarly the ability to spot-weld and seam-weld this material has paved the way for many new applications.

Pure nickel is finding uses for chemical equipment. The chrome-nickel alloys are being used more extensively in dairy equipment, pumps, oil field equipment, valves, food machinery and for corrosion resistance at high temperatures.

Beryllium copper, famed for its fatigue resistance, is also being selected for its corrosion resistance. Probably no other metal possesses the property of combined fatigue strength and corrosion resistance to such a remarkable degree as beryllium-copper. This is leading to its rapid adoption for valve springs, scale springs, and parts subjected to hammer blows. And because it is non-sparking, it is also being used for tools. Of the reporting companies, 65 per cent of the manufacturers of scales and instruments, 12 per cent of manufacturers of heating and ventilating devices and equipment, 25 per cent of the airplane and engine manufacturers and 15 per cent of the pump and valve manufacturers are using beryllium copper.

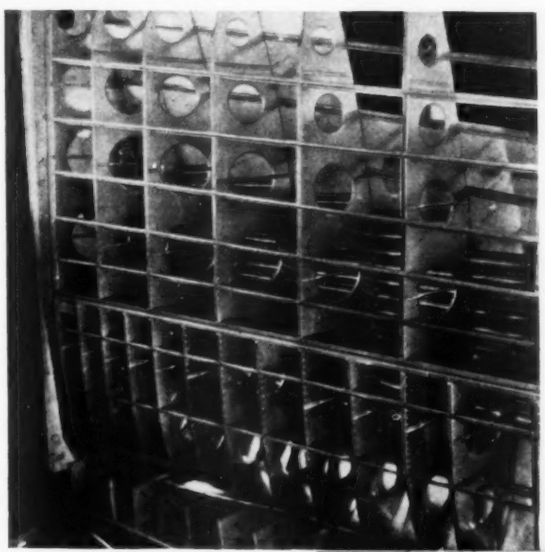
Of the non-metals rubber and vulcanized fiber are favored for their corrosion resistance. But vulcanized fiber is favored more for its wear resistance, surface finish and noise isolation. For this last purpose, rubber takes first place with cork and felt tied for second. These two materials hold the same ranking for vibration damping.

Where Light Metals Are Being Used

FIELD OF MANUFACTURE	Aluminum Alloys	Magnesium Alloys
	(Per cent of companies reporting)	
Airplanes	100	100
Packaging Machinery	52	20
Production Machinery	30	9
Engines	35	2
Motors, Clutches, Speed Reducers, etc.	25	10
Construction & Mining Machinery	28	10
Household & Office Machinery	43	9
Agricultural Machinery	25	0
Textile Machinery	46	0
Scales, Instruments, etc	40	10
Locomotives and Railroad Equipment	70	30
Heating & Ventilating Equipment	44	8

For light-weight design, aluminum alloys are favored by 30 per cent of the reporting companies, distributed among all fields of mechanical design. A marked increase in the use of aluminum alloys for textile machinery, construction and production machinery, engines and packaging machinery is indicated. For buses, trucks and railroad equipment, aluminum sheets, structural sections and extruded shapes have received wide adoption. A recent development is locomotive driving rods of aluminum alloy to decrease inertia forces.

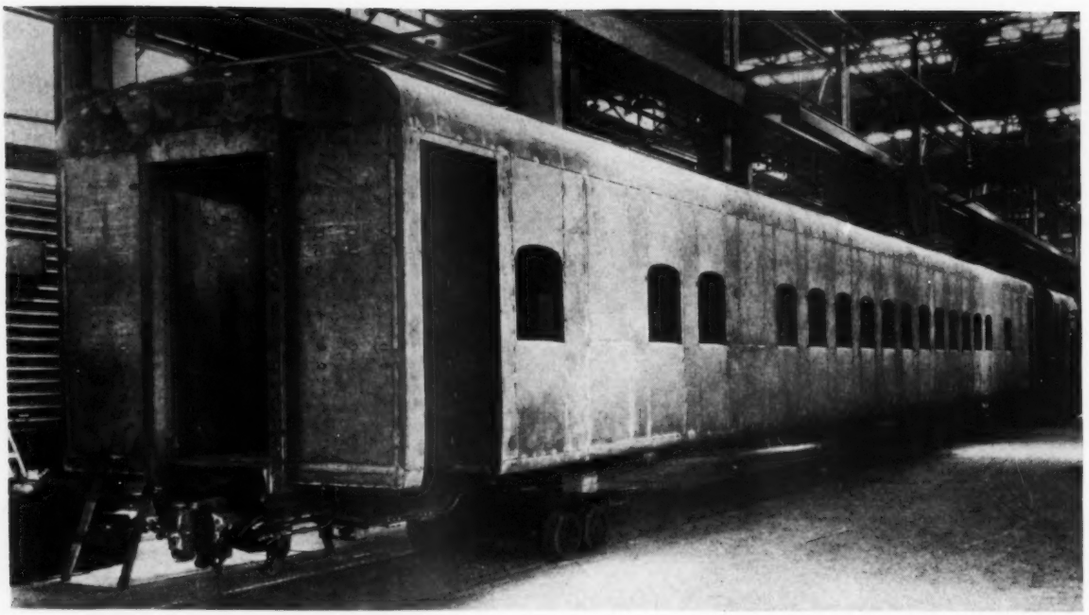
There is also indicated a remarkable increase in the use of magnesium alloys for light-weight construction.



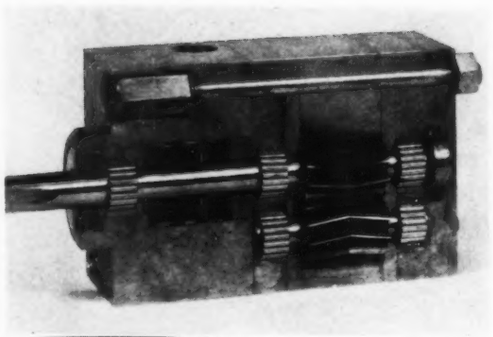
A wing panel used on the Lockheed Electra showing a typical aluminum-sheet structure

Magnesium alloy castings reduce forces and bearing loads in the Slicewrapper (page 411)

Aluminum alloy castings eliminate weight in Black & Decker line of electric hand tools



Arc welded construction using Cor-Ten steel reduced the weight of new streamlined passenger coaches by 50,000 lb.



Nitralloy parts resist wear and abrasion in Northern pumps designed for oil, kerosene, gasoline and fuel oil

These alloys are receiving 25 per cent more attention than a year ago. Used in various forms, magnesium alloys are finding their way into all fields of product engineering. Typewriter parts, food machinery, production equipment, and general machine parts are among the products using magnesium.

Demand for increased speeds is the biggest single factor that is bringing about a wider use of light materials. In the new bread slicing machine recently designed by the American Machine and Foundry Company, aluminum was used primarily to permit higher speeds by virtue of the smaller inertia forces resulting from the decreased weight. The Royle Company uses Dowmetal for the table frame casting of their machine for beveling, sawing, routing, trimming and mortising photo-engraved plates. One typewriter company has experimented with the use of Dowmetal solely for the purpose of saving weight.

A textile machinery designer reports that he uses stampings for light weight and molded plastics where both light weight and electrical insulation are required.

Stellite facings are used on high pressure steam valves to increase service life and reduce maintenance cost

The use of welding for light-weight construction is increasing continuously. Two factors are contributing to this. One is further developments in both resistance and fusion welding and the other is the further adoption of flame cutting. Improvements in flame cutting machines has greatly reduced the cost of cutting irregular shapes out of heavy plates, with the result that welded plate steel machine frames and foundations are finding more favor. Some welderies have been equipped with large annealing furnaces, making it possible for them to stress anneal large welded structures. Among the outstanding welded machines developed during the past year are a large welded steel press and a machine for grinding rolling mill rolls up to 48 in. in diameter.

New machines for resistance welding have been developed for flash, seam and spot welding and this type of construction is finding wide adoption among designers of all kinds of cabinets such as for refrigerators, gas ranges, electric stoves and similar types of products. Economy is reported as being the principal reason for using resistance welding. One engineer commented that, "We unite various elementary parts to their assemblies by resistance welding, making accurate, nonvariable and inexpensive structures. We design many assemblies to have lugs, mounting clamps, and similar parts attached by resistance welding."

The chief engineer of one of the largest manufacturers of dairy equipment states their tendency is to use stampings in greater quantities, and that welded joints are rapidly taking the place of soldering and brazing.

Indicative of the possibilities in tubular design, Kroyden have developed a simple method of tapering steel tubing for golf stick shafts. A manufacturer of fishing rods has perfected a similar development. Stainless steel and pure nickel seamless tubes with wall thickness less than 0.002 in. are used for hypodermic needles and in radio tubes. Stainless tubes are also finding applications in pressure gages and recording instruments. And because such tubes can be obtained to extremely close tolerances and finish, they can be nested without requiring any further finishing. For this reason they are used extensively wherever tubes must be nested, as in projectors and other telescoping parts.

Wear and Abrasion

To combat wear and abrasion, alloy cast iron heads the list of metals reported used. This is indicative of the many designers who are switching from ordinary cast iron to the alloy cast irons, primarily for greater strength and wear. But for severe wear conditions, hard facing materials such as Stellite and Carboloy are favored most, with nitriding next and the alloy steels following. The various bronzes are on the same par as the alloy steels, but are usually favored where corrosion resistance is also a factor. Beryllium copper

Materials for Wear Resistance

FIELD OF MANUFACTURE	Hard Facing	Bronze	Beryllium Copper
	(Per Cent of Companies Reporting)		
Engines, Pumps and Valves	25	5	5
Speed Reducers, Clutches and Couplings, etc	2	11	–
Construction and Mining Machinery	16	7	–
Production Machinery and Equipment	9	3	5
Airplanes and Engines	12	18	6
Textile Machinery	18	18	–
Scales, Instruments and Controls	15	5	10

Clutch fingers with Stellited working surfaces last longer, and as they are not hardened, quenching cracks are avoided

Hard facing is now widely used for automotive valve seats. This seat is faced with Haynes Stellite

Drilled diamond nozzles for oil burners, a new development to overcome corrosion and abrasion

Nitrided firing disks are used in the Detroit Lubricator Company's nozzles

Cherry-Burrell's milk-bottling machines make extensive use of stainless steel

takes a prominent place in the manufacture of sensitive instruments and controls where it is used for its exceptional combination of fatigue strength, wear resistance and corrosion resistance.

In the manufacture of engines, pumps and valves, hard facings for wear are predominant. It is indicated that these materials are selected also for their corrosion and impact resisting properties in combination with wear resistance. Construction and mining manufacturers, however, choose them primarily for wear resistance as do the production machine makers.

It is also indicated that whereas formerly the purchaser of the machine was forced to make the initial application of hard facing material as a repair job, manufacturers are now beginning to apply the material to the machines as manufactured.

The Northern Pump Company use Nitralloy extensively for their line of pumps, the outstanding feature being that the gears are not distorted by heat-treatment, thereby retaining the tooth contour as machined and ground. Shafts, gear side plates, thrust collar and pump body are all made of Nitralloy.

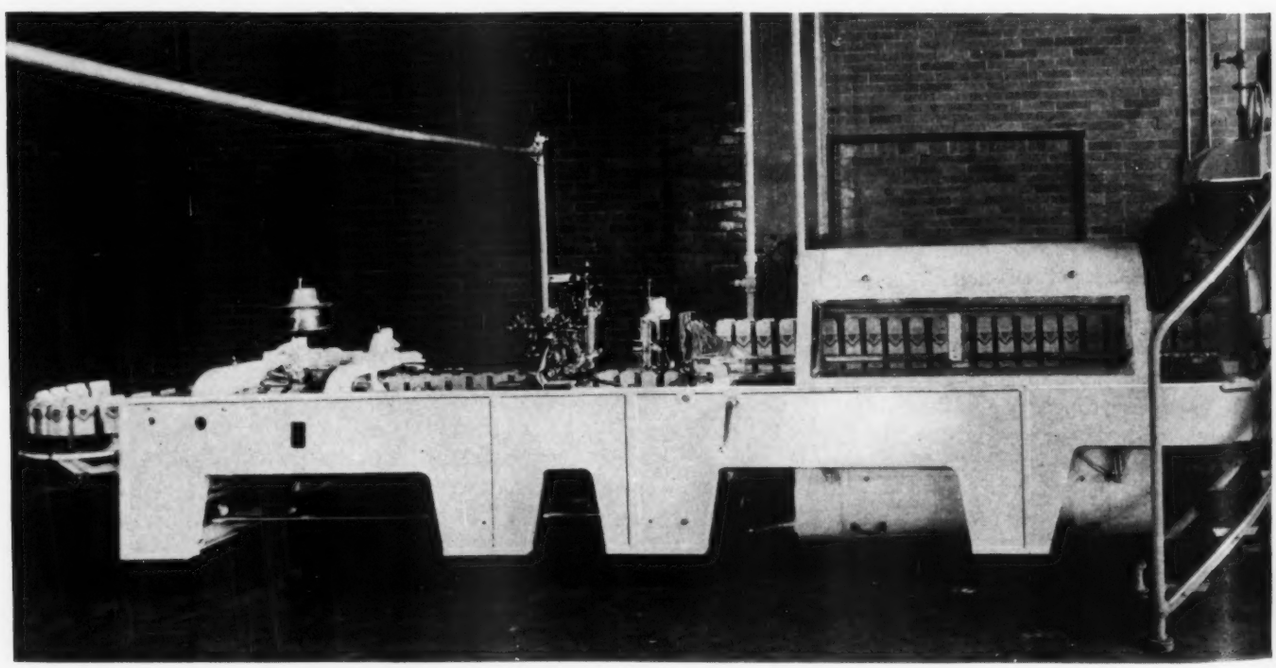
Firing disks for Detroit Lubricator Company oil burner nozzles are nitrided steel. Gate and globe valve seats and valve disks faced with cobalt-chromium-tungsten are claimed to give 6 to 10 times longer life. Dredging bucket lips are hard faced to overcome the abrasive action of sand. Thresher teeth usually lasting only 30 to 40 days were hard faced and gave 10 times longer life.

Aluminum automobile pistons are hard surfaced by Alumiliting which forms a smooth oxide surface as an integral part of the piston. This is not to be confused with a layer of material deposited on the surface.

U. S. Electrical Manufacturing Company use chromium plating on sliding and non-rotating surfaces to combat wear and corrosion where lubrication is infrequent. The multi-flame Linde welding head has a chromium plated stem and tip to prevent erosion.

Taylor-Wharton Iron & Steel Company use chrome, chrome-nickel and chrome-nickel-moly to overcome wear in centrifugal pumps.

Ampco bronze is used by another company in place of ordinary bronze, cast iron or hardened faces against hardened steel, in order to avoid crushing and galling.



This material is also used for draw dies to eliminate scratching and on press dies to overcome acid corrosion.

The foremost reason given for using bronze alloy was because of its wearing qualities, but its high strength and corrosion resistance were indicated to an almost equal extent as the reason for its adoption. In a number of instances, bronze die castings were specified for their combination of wear resistance, strength and surface finish, in addition to corrosion resistance.

Vulcanized fiber in sheet, rod and tube form is used to a great extent in the textile field. It is used for wear, vibration damping, noise isolation as well as for applications requiring a smooth surface.

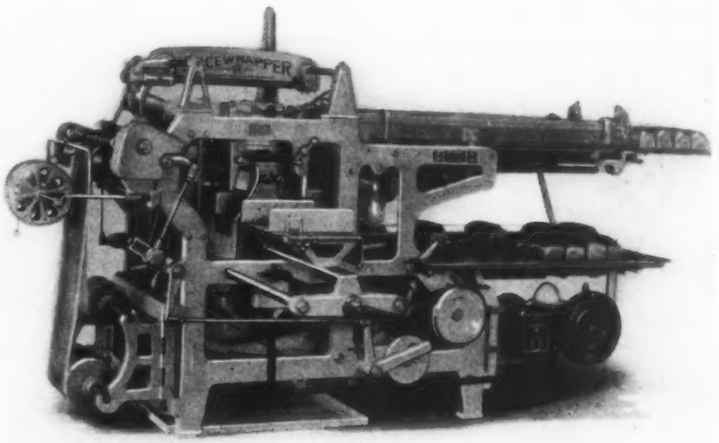
Corrosion Resistance

The effort to overcome corrosion is evidenced by the extensive use of alloyed metals, both ferrous and nonferrous. From the table it will be seen that chrome-nickel steels are most popular. Of the companies reporting the use of this family of steels 50 per cent list corrosion resistance together with its high strength as the main reason for its use.

Wisner Manufacturing Company state that for dairy equipment there is a tendency toward stainless steel in place of tinned copper, thereby avoiding chipping and peeling. Strength, lustre, and surface cleanability warrant its use. All joints are welded, ground and polished.

Cherry-Burrell Corporation use the same material where it comes in contact with milk products, the requirement being that the finish shall not be attacked by the milk or be soluble in the milk to affect its flavor,

The American Machine and Foundry Company uses alloy steels, aluminum and magnesium for lightness in their high-speed bread slicer. A Reeves variable speed pulley permits a 3 to 1 speed variation



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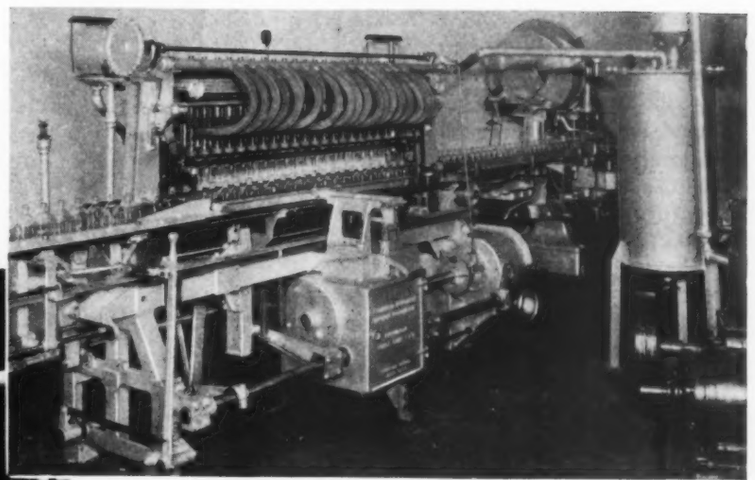
Chrome-nickel alloys in the Pneumatic Scale Company's bottling machine are used for strength and corrosion resistance



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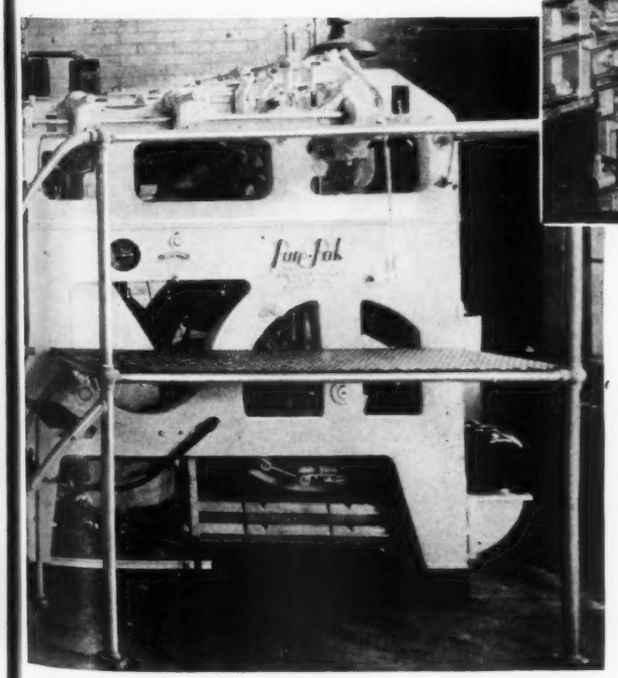
All parts that come in contact with food are 18-8 stainless steel in the machine shown below, designed by the American Paper Bottle Co.



neither shall it discolor. Lee Metal Products Company, Inc., use stainless steel, nickel and monel for food handling equipment in place of copper, aluminum and glass linings. Cable fittings for aircraft and yacht riggings of stainless steel, to be immune to corrosion through contact with salt water spray and salt air, are made by The Fiege Company.

Cast nickel-silver parts are used in an ice cream cup filling machine. Because of the greater tarnish resistance obtained, a hardware manufacturer has changed from 20 per cent nickel-silver to 25 per cent nickel-silver for white metal hardware.

Materials Used Primarily for Resisting Corrosion

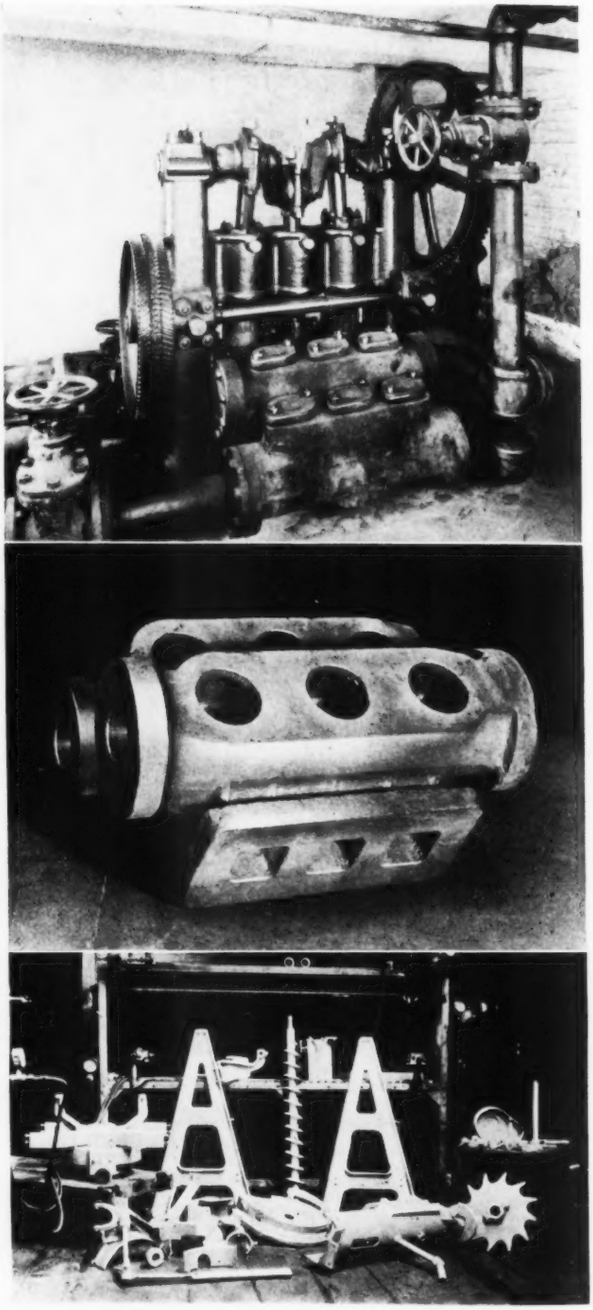
Field of Manufacture	Stainless Steel	Aluminum Alloys	Copper Nickel Alloys	Nickel	Bronze	Beryllium Copper
	(Per cent of Companies Reporting)					
Engines, Pumps & Valves.....	47	13	8	5	10	5
Heating & Ventilating.....	40	8	4	4	.....	.....
Instruments & Controls....	50	10	5	5	5	10
Airplanes & Engines....	42	.....	.....	.....	6	12
Household & Office Equip.	10	20	5	.....	.....	5
Agri. Mchy. & Dairy Equip.	62	12	12	25	.....	.....
Miscellaneous.	18	6	6	.....	6	6

In the design of the forged pipe unions of the Central Forging Company a stainless steel ring is locked in as shown in the accompanying illustration. This serves to provide corrosion resistance at the joint, resulting in not only superior serviceability but also a product having greater durability.

Ingersoll Steel & Disc Company reports that stainless clad steel is being regularly furnished from No. 20 gage up to 2 in. thickness with a 20 per cent layer of stainless steel bonded to a mild steel foundation.

Molten metal spraying in which a coating of metal is deposited on any base is being used to combat corrosion. Air Reduction Sales Company reports the spraying of the inside of 500 gallon copper tomato cooking kettles with a coat of molten tin 1/32 in. thick. Cast bronze fruit juice presses are sprayed with a 0.012 in. coat of German silver to prevent corrosion. Locomotive tubes are sprayed with zinc, either on inside or outside as required. U. S. Electrical Manufacturing Company uses sprayed metal for rendering surfaces resistant to corrosion outdoors.

For sand castings and die castings, alloy cast irons and steels and alloy aluminum are favored for corrosion resistance. Stainless steel is used to combat chem-



For use in chemical processes, the Worthington triplex pump (top) has a chrome-nickel iron cylinder casting (center) made by the Lebanon Steel Foundry. Canning machine parts are protected from the corrosive action of fruit juices by molten aluminum applied by the Air Reduction spray process. Pump impeller (left) of silicon bronze is die-cast around a sand core by the Aurora Metal Company

ical corrosion in pumps. Aluminum alloy sheets for reflectors made by Westinghouse Electric & Manufacturing Company are treated by the Aluminum Company of America by the "Alzak" process to prevent corrosion, to keep them from darkening, turning white or staining under atmospheric conditions, and to resist salt solutions and dilute acids.

Westinghouse uses beryllium copper on some of their products because of its corrosion resistance and high strength over ordinary copper and bronze.

Prefinished sheets with tin, nickel, chromium, or other metals plated or coated on a base sheet of steel, zinc or copper have been found by many manufacturers to be an economical method for getting a finished corrosion resisting surface having a good appearance as well. Improvements in such prefinished sheets permit them to be drawn and shaped without marring the surface. Besides their use for gift and novelty products, such sheets are being used for reflectors, decorative trim, fan blades, cases and similar applications.

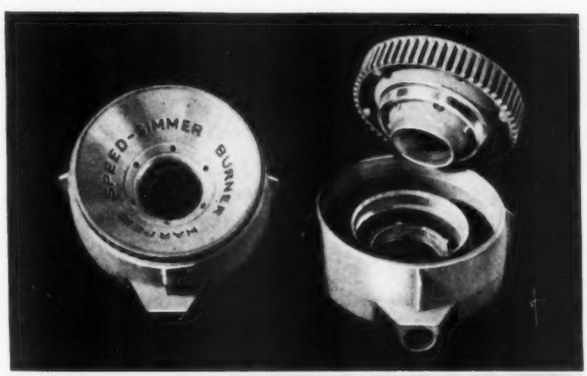
One company has developed a full line of marine hardware made of cast chrome nickel alloys running about 66 to 68 per cent nickel and 19 to 21 per cent chromium.

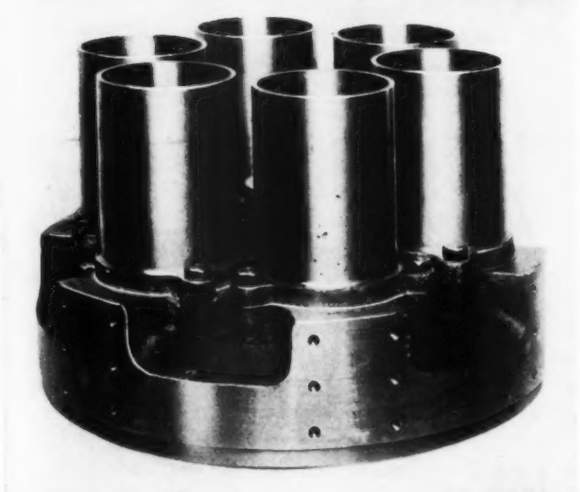
Almost 30 per cent of the manufacturers of scales, instruments and controls reported the recent or contemplated adoption of stainless steel. This material is now being used for instrument shafts, housings, and miscellaneous small stampings. Further developments are under way.

Corrosion resisting balls for check valves used in oil refineries and oil fields are made out of nickel-chromium. The balls are cast hollow, the core then being shaken out through small holes left in the ball and these holes then being welded shut.

Carburizing boxes cast of 66-68 Ni. and 19-21 Cr. are made by General Alloys with an extremely thin wall in order to get the maximum rate of heat transfer into the carburizing box. In order to get such a thin wall section, the long boxes, about 36 in. long, are made in three pieces, two end pieces and a middle section. The three sections are arc welded together. A quite similar construction is wherein the side sheets of the box are put in the mold and the box corners are cast, the results being that the side sheets and the case corners are fused together.

To resist corrosion: Stainless steel inserts in the union made by Central Forging, aluminum in the Standard Gas Equipment burner, and Michiana chrome-nickel castings for a food machine part



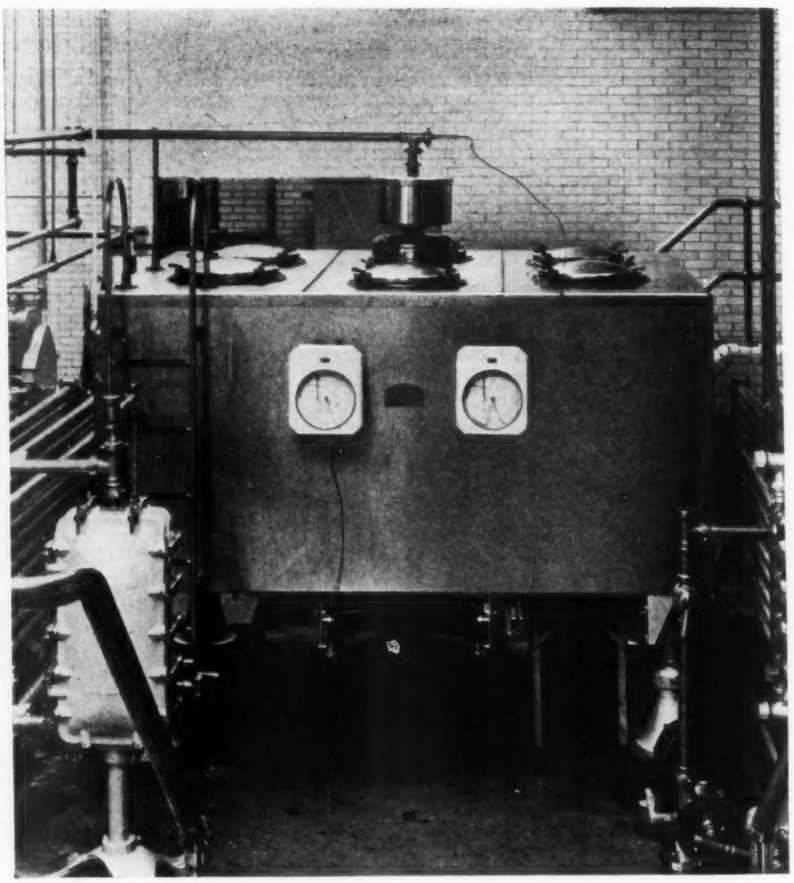


Cast aluminum burners for domestic gas ranges, first offered as optional equipment, are now standard on many of the high-quality ranges. But the oven burners are still cast iron because the inverted flame discolors burners regardless of the kind of burner material used. Stainless steel is being used for gas range tops. For chemical equipment, Monel, nickel and stainless head the list.

Stampings for Economy

Cost being the primary consideration, it is not surprising to find that designers are turning to stampings for parts of construction machinery, transportation equipment, household appliances and heating and ventilating equipment. Welding, both resistance and fusion, is reducing costs for designers of production machinery, automobiles, and all types of equipment for the home. Copper alloy die castings are also shown to be an important cost-reducing factor in the construction of engines and accessories where high strength, irregular shape and excellent surface finish combine to reduce machining expense. Cold drawn sections are reported to be cost reducing factors in the design of scales, instruments, and packaging machinery.

Although cost is the first consideration, the survey shows a remarkable increase in attention being given to weight reduction, not only in aircraft and airplane engine design but also in construction machinery, machine tools, household appliances and instruments. Foremost in types of construction for weight reduction is the use of aluminum die castings, with stampings a close second. Light weight combined with excellent



In the Wisner automatic pasteurizing outfit, stainless steel is used for the tank, filter, pump, cooler and pasteurizer. Instruments are provided for precision control

surface finish places molded plastics in a leading position in the design of instruments and appliances.

When good surface finish is desired, the survey shows that die casting or molding processes are favored in every field of manufacture. With plastics leading in popularity, bronze die castings, zinc and aluminum die castings rank next in order, with considerable attention also given to cold drawn and extruded materials.

For compact design combined with the use of irregular shapes or surfaces the survey reveals that zinc die castings are finding the greatest attention, particularly in the design of engines, automotive accessories and household equipment. Fusion and resistance welding also are resulting in more compact design, at the same time reducing the weight of construction machinery, machine tools and automobile bodies.

Drop forgings are favored for parts subjected to stress and impact, giving a lighter, more compact design in production machinery and engines. Copper alloy die castings likewise are shown to be popular for high strength parts where a good surface finish is needed. Fusion welding has also found many high strength applications among all groups of machinery designers.

Types of Construction

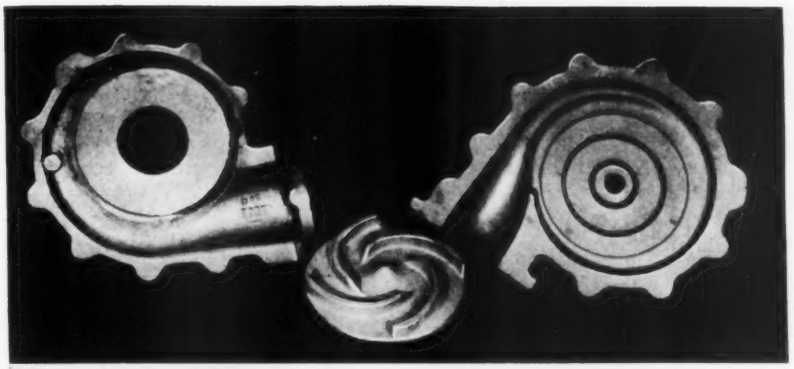
The thin wall sections now obtainable in die castings have had a noticeable effect in extending the field of application of this type of construction. Among the most recent new developments, the substitution of zinc die-cast frames for automobile heaters, in place of stampings, can be mentioned, electric meter cases made as zinc die castings, a new design of cigarette vending machine made almost entirely of zinc die castings, including the housing. One manufacturer uses zinc die castings throughout for the frame of a new design of washing machine wringer. The frame of the Woodstock typewriter is a one-piece zinc die casting. The home canning machine manufactured by the Metal Package Corporation has almost all the parts made of zinc die castings, as illustrated on page 416.

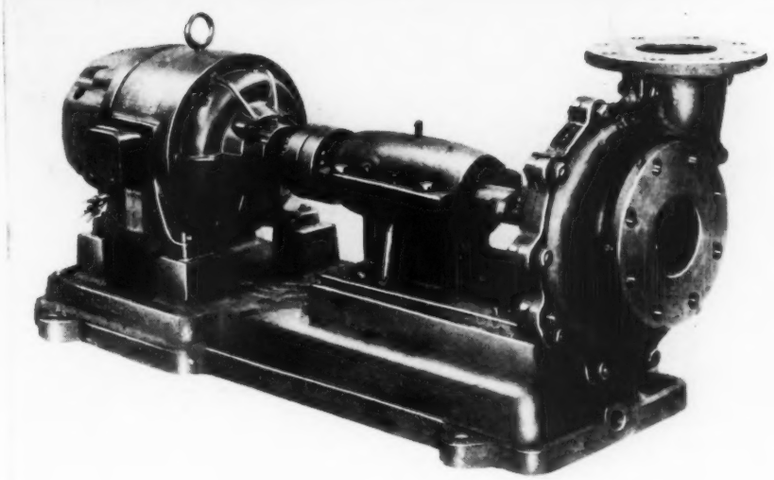
From the data and information uncovered in this survey, it is evident that one of the methods for economical design with die castings is the use of inserts. This type of construction seems to be receiving particular attention in connection with high-strength die castings. Bronze worms die cast on the ground steel shaft, inserted steel for wear resistance and added strength for brackets and similar parts, are examples of this type of construction.

One interesting design shown in one of the pictures is an aluminum bronze die casting with a phosphor bronze liner insert. In this application, the phosphor bronze insert is for the purpose of providing a better bearing surface, the part sliding longitudinally on a shaft in a bottle capping machine. Aluminum bronze was selected both because of its strength and corrosion resistance.

Although metallic inserts are common in die castings, when necessary, inserts of phenolic material can be used, provided that the insert has no small projection of low thermal capacity. In the zinc die casting forming the frame for an electrical instrument, the lower bearing screw was insulated by the use of such an insert, simplifying the design and reducing assembly cost.

By making the diameter of the insert large, leaving but a small section for the die cast metal, the hot zinc, when forced around the insert, cooled so quickly that





Single-stage chemical pumps made by the Frederick Iron & Steel Company use cast stainless steel for corrosion resistance. Volute and impeller castings made by the Lebanon Steel Foundry

no burning of the insert occurred. To prevent the insert from turning, a groove is turned into the portion surrounded by the die casting.

Tubular construction, widely used in airplanes, is finding many applications in other fields. Closer dimensional tolerances in tube diameters, new developments for processing the finished tubes, welded construction and the availability of tubes of various alloys, have all contributed to their wider use.

Advantages Found in Recently Adopted Types of Construction

TYPE OF CONSTRUCTION	Light Weight	Compact Design	Special Shape	High Strength	Surface Finish	Low Cost
	(Per Cent of Companies Reporting)					
Stampings.....	56	20	24	21	23	85
Molded Plastics.	39	35	36	8	54	52
Molded Rubber.	18	11	18	–	18	68
Die Castings:						
Aluminum.....	60	21	29	–	26	64
Zinc.....	28	42	50	14	31	30
Bronze.....	12	19	25	38	32	76
Extruded sections.....	27	8	22	34	22	68
Cold-Drawn Shapes.....	16	23	37	24	27	67
Drop Forgings...	42	26	28	56	21	75
Resistance Welds	28	28	18	27	13	77
Fusion Welding..	26	36	22	25	9	80

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With reference to fastenings, there is a continued trend toward the hollow-head screw. The vice-president in charge of engineering of a machine-tool company stated:

"Hollow-head screws enable us to save space and material by cutting down the width of bolting-down flanges. And it is usually easy to counterbore for the head of the hollow-head screw, resulting in smooth clean surfaces that not only add to the appearance of the machine but also are an element of safety.

"But there is one sales point for machines that are equipped with hollow-head screws that I have never heard mentioned. The wrenches for hollow-head screws are much smaller and lighter than those for hex-head screws. I heard a maintenance man say that he preferred hollow-head screws because he could conveniently put a complete set of wrenches for them in his pocket."

Anti-friction Bearings

Many significant developments have led to extended application of anti-friction bearings. The most recent development of bearing manufacturers has been that of the "sealed-in" bearings in which both sides of the bearings have been sealed in with flanges overlapping the inner races. These bearings are filled with grease at the ball bearing manufacturer's plant and receive no further lubrication during the life of the bearing.

As disclosed by this survey, engineers have been quick to take advantage of the sealed-in anti-friction bearing. As shown by the accompanying tabulation, more than 36 per cent of all the manufacturers of the type of machinery and equipment listed have recently adopted this type of anti-friction bearing.

Many advantages are claimed for this type of bearing, including the exclusion of foreign matter, retention of lubricant, and the elimination of the necessity for attention to lubrication while the machine is in service.

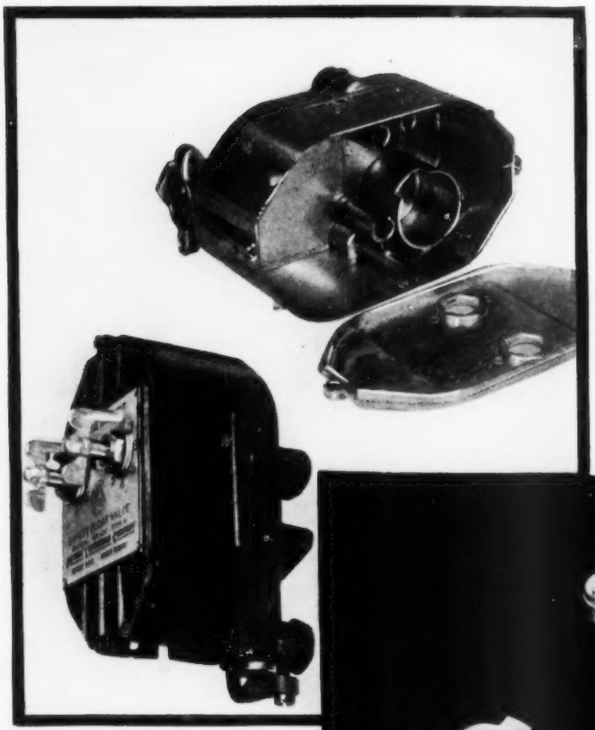
Another development in the field of anti-friction bearings has been further improvements in their manufacture, resulting in the precision and super-precision bearings, designed especially for application where ab-

sence of play and high-speed easy running are of prime importance. It is also claimed that the super-precision bearing not only permits greater speed, but also has a longer life. One manufacturer reports an average life of 2,000 to 3,000 hours under normal conditions at the highest speeds. When used in grinders designed for difficult finishing jobs requiring exceedingly close work the bearing life will be but approximately 500 hours. This performance, however, is from 100 to 200 per cent better than the life obtained with conventional bearings. Some of the smaller sizes of these super-precision ball bearings have been operated at speeds of 52,000 to 60,000 r.p.m. with a reasonable life.

New types of anti-friction bearings designed to reduce mounting expense are also a factor in recent developments. In fact, the chief engineer of one of the prominent makers of automatic screw machines states, "In the use of ball bearings, the major cost has been in the mounting, and I feel that the flange type ball and roller bearing represents even greater economy.

Bearings and Bearing Seals

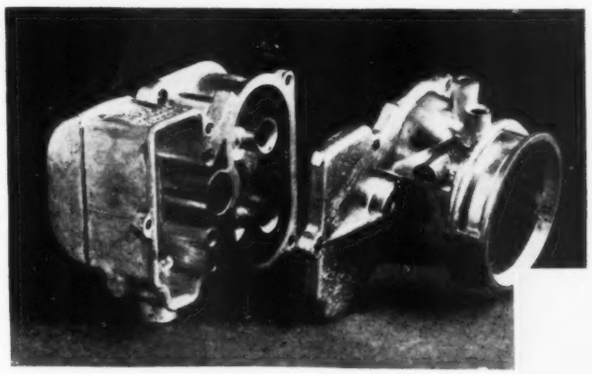
FIELD OF MANUFACTURE	Anti-Friction Bearings	Sealed Anti-Friction Bearings	Bearing Seals: For Anti-Friction Bearings	Bearing Seals: For Sleeve Bearings	Oilless Bearings
	(Per Cent of Group Reporting)				
Production Machinery & Equipment	52	38	52	15	37
Construction & Mining Equipment	66	38	55	18	15
Motors and Speed Reducers	29	32	32	14	29
Textile Machinery	64	46	27	9	36
Packaging Machinery	40	27	20	13	47
Airplanes and Engines	47	47	24	12	41
Engines, Pumps and Valves	40	23	48	13	25



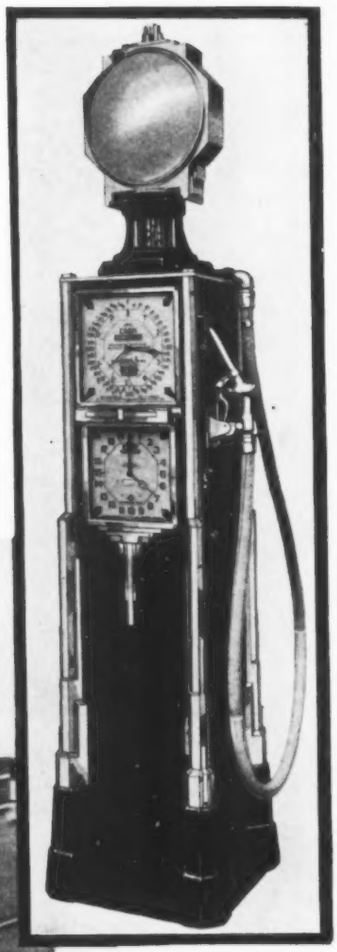
(Above) Intricate coring in the casting die reduces the number of parts in the housing of the float valve designed by the Detroit Lubricator Co. (Right) Can sealing machine manufactured by the Metal Package Corp. uses 28 die-cast parts made by Advance Pressure Castings, Inc. The 9-lb. frame requires cores pulled from four directions

I believe that the flange type bearing will be the universal bearing of the future."

Hand in hand with the application of the sealed-in type of anti-friction bearing, the use of bearing seals is finding wider application. As shown by this survey, 37 per cent of the machinery manufacturers included in this group are now adopting bearing seals for anti-friction bearings, while 36 per cent are now resorting to the sealed-in type of bearing. Of course, there is considerable overlap in this tabulation and many of the manufacturers who are using the sealed-in type of bearing are also adopting bearing seals.



Two Madison-Kipp die castings involving complicated coring, close tolerances and thin sections, make up the entire body of the Stromberg carburetor



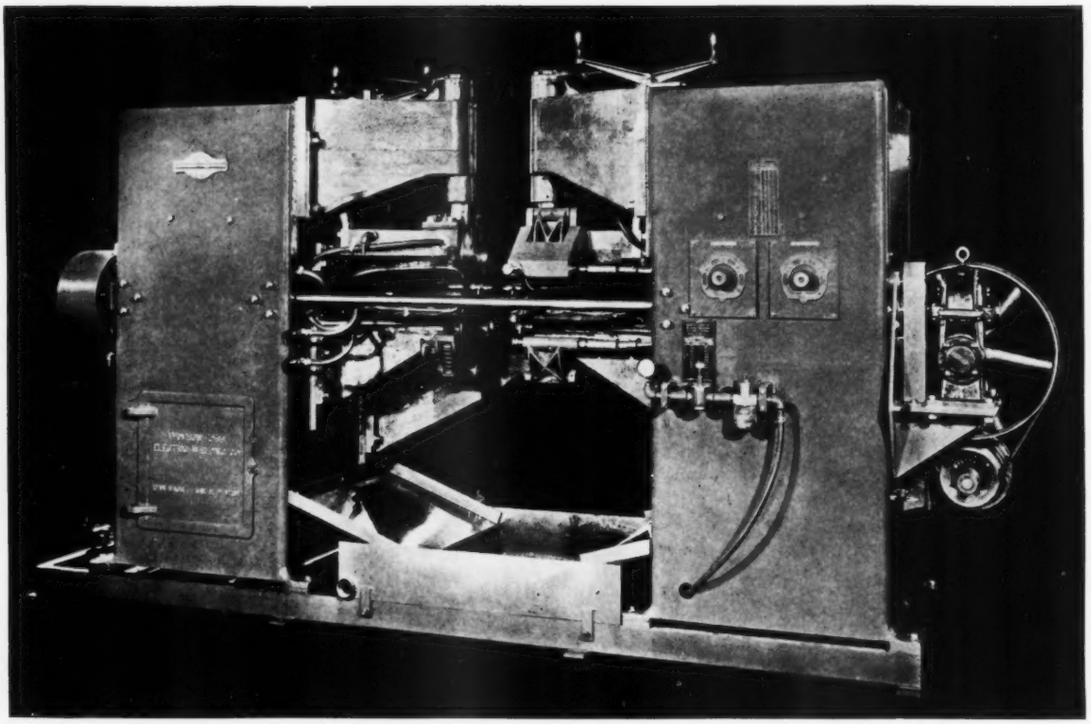
Zinc die castings are used for the trim on Erie gasoline pumps. For finish, the trim is lacquered or chromium plated

One of the leading manufacturers of cranes is now using roller bearings for mounting truck wheels, reducing the operating and maintenance costs, conserving power and lubricants, and reducing starting loads on the gears and motors. These trucks which formerly were sand castings are now made from welded structural shapes and plates machined to receive the roller bearings.

For sleeve-type bearings also, increasing attention is being given to the application of bearing seals. Apparently, designing engineers are now coming to the conclusion that the sleeve-type bearing should be afforded the same protection as is given to the anti-friction bearing. And in view of the fact that the degree of freedom from maintenance and the life of the bearing is largely dependent upon the degree of protection that it receives, it is only logical that the same degree of protection should be afforded all types of bearings.

In the design of construction and mining equipment, where abrasive dust and dirt are an ever-pressing problem, 18 per cent of the manufacturers have recently adopted or contemplate the adoption of bearing seals for the sleeve-type bearing. It is in this same field that 55 per cent of the manufacturers have considered anti-friction bearing seals. Following in order after construction and mining equipment come production machinery, engines, motors and speed reducers, textile machinery, airplanes and engines, and finally packaging machinery.

Although not included as an item on the questionnaire, a separate investigation of recent or expected adoption of "needle" type of bearings using small diameter rollers, shows that this type of radial anti-friction bearing has gained very rapid popularity in the automotive industry during the past few years. From the experience gained in producing rollers for free-wheeling clutches there developed the commercial high speed production of rollers suitable for the present "quill" types of bearing. One of the difficulties in the first applications of these bearings to free-wheeling clutches was that in some instances rollers crushed under the



Thomson-Gibb resistance welder, equipped with a Reeves variable speed drive, makes four seam welds simultaneously on shock absorber housings

impact loads and stresses when the load was taken up between the cam faces. Recent investigations have developed heat treatments that give sufficient hardness to withstand the wear, at the same time maintaining sufficient ductility to resist crushing under shock.

Among the first applications of small diameter rollers in volume production were universal joints made by the Universal Parts Company. The success of this application was so outstanding that this type of construction has now been adopted by nearly all of the universal joint manufacturers. For this application, the quill type bearing had two advantages: first, it provided for maximum carrying capacity per sq.in. of projected area of the bearing, and second, it solved the lubrication problems since the bearings could be packed with sufficient lubricant to last the life of the machine.

Other successful applications of small rollers or needle bearings are found in countershaft gears on conventional type transmissions in automobiles, where these small rollers have the advantage of taking little or no more space than a bronze bushing. Because of the greater compactness obtainable, this type of bearing is also used for some mainshaft pilots for automobile transmissions, reverse idler gears and the various lay shafts on multi-speed truck transmissions.

The investigation shows that economy is another factor in the application of the needle type bearing, the cost of the small rollers being as low as 0.1¢ each in volume quantities. These rollers are used either with both inner and outer race, or only an inner or outer race, the type selected depending only on the hardness of the shaft and housing.

Packard connecting rod bearings have replaceable copper-lead liners

Among the most recent new applications of this type of bearing in the automotive industry, are their application to the Chevrolet independent springing, the Hudson axle-flex pivot joint, the king pin of the Chrysler Imperial and Chevrolet cars, Chrysler steering gears, and the clutch pivot finger bearing on the Packard and Lincoln cars and General Motors trucks.

Oilless Bearings Find Wide Use

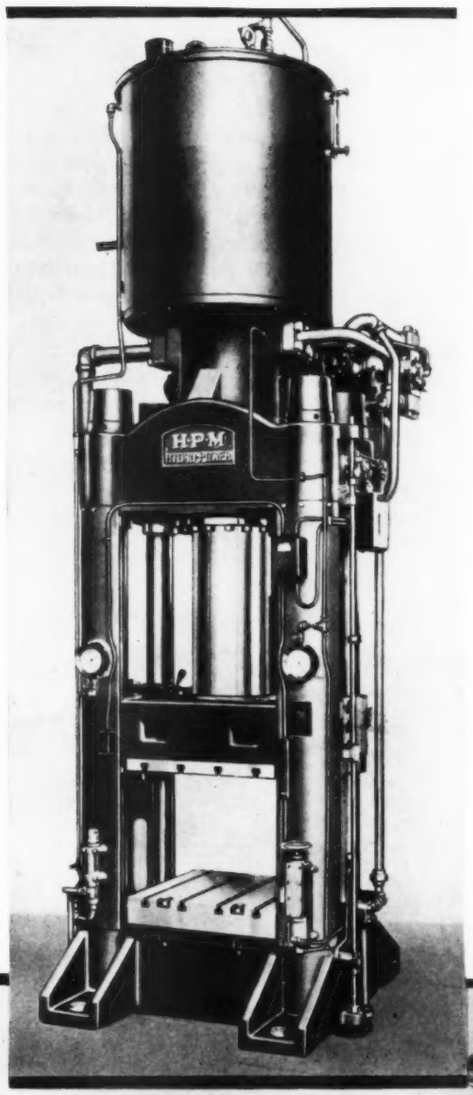
Lubrication problems are closely allied with the selection of the type of bearing. In the accompanying tabulation is shown the percentage of new or recent adoption of various types of lubricators and lubricating devices and accessories for manufacturers in the various groups.

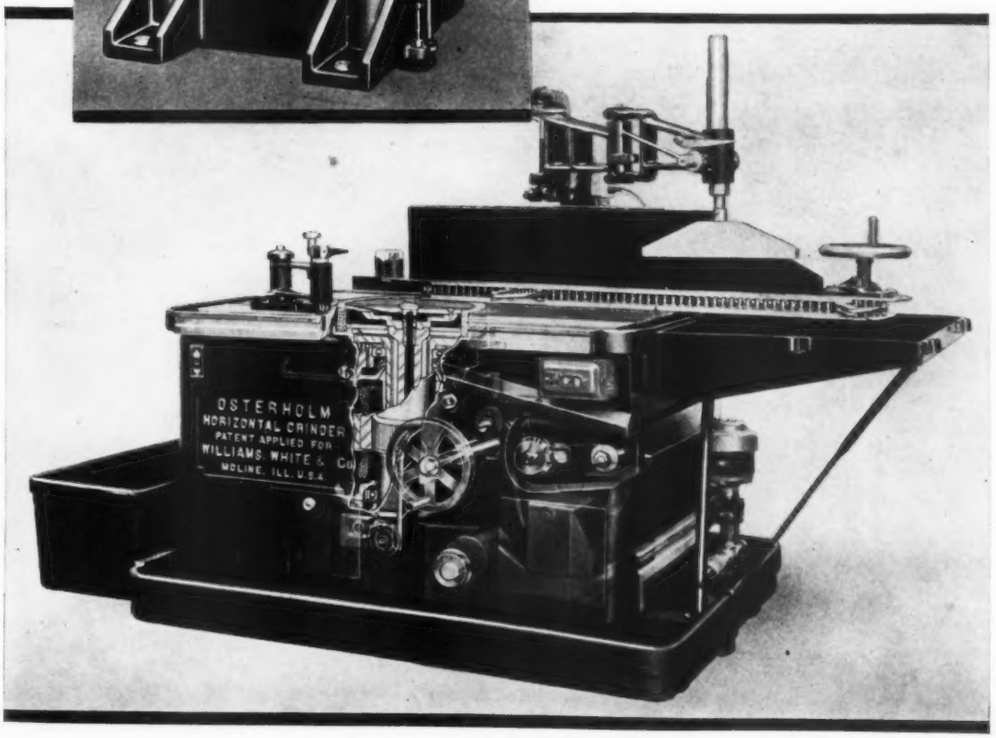
It is interesting to note that in the field of textile machinery—which has the unjust reputation in many minds of being too conservative in their design development—45 per cent of the manufacturers have made

further developments in the application of lubricating devices. In the new Model "E" wool spinning frame, developed by the Whitin Machine Works, Mr. W. H. Greenwood of that company reports that they use the 1-shot system of lubrication, consisting of a central oil reservoir and pump with a network of oil pipes to distribute the oil to the individual bearings. Operation of the pump handle at regular intervals furnishes the correct amount of lubrication to the bearings served by the system. Points otherwise hard to reach and that might be overlooked because of inaccessibility, get the correct amount of oil regularly. For each bearing, the

Lubrication

FIELD OF MANUFACTURE	Lubricating Devices	Pressure Lubrication	Central Lubrication	Oil Filters	Flexible Tubing	Leather Seals, Gaskets and Washers
	(Per Cent of all Companies Reporting)					
ProductionMachy and Equipment.	35	35	35	27	25	32
Construction & Mining Equipment.....	17	31	21	21	17	45
Motors and Speed Reducers.....	17	7	10	4	7	35
Textile Machinery.....	45	18	18	–	18	18
Packaging Machinery.....	20	13	13	–	20	20
Airplanes and Engines.....	6	18	6	24	47	18
Engines and Pumps.....	15	15	5	10	23	27
Heating and Ventilating.....	20	8	4	–	16	16





In the H-P-M press (above) the die cushion is self-contained with a direct motor drive mounted on the press head. Spindle motor (left) and spindle bearings are well protected from dirt and grinding fluid in the Osterholm horizontal grinder

size of valve or orifice is selected so that the amount of oil applied to the bearings will be proportioned to the diameter and length of the bearing and the speed of shaft. All important bearings in this machine are bronze bushings, small oilless wood bearings being used for steel pulleys that serve as idlers.

In the field of textile machinery, one manufacturer reports the development of a new machine that involved the application of approximately 400 oilless bearings. Taking into account the amount of time that would be involved in giving lubrication attention to such a great number of bearings, or the complication that would be involved in providing them with central lubrication, it is natural that the oilless bearing should find favor for such an application.

As shown by the accompanying tabulation, production machinery and equipment rank first in the per cent of new applications of pressure type of lubrication, with construction and mining equipment second.

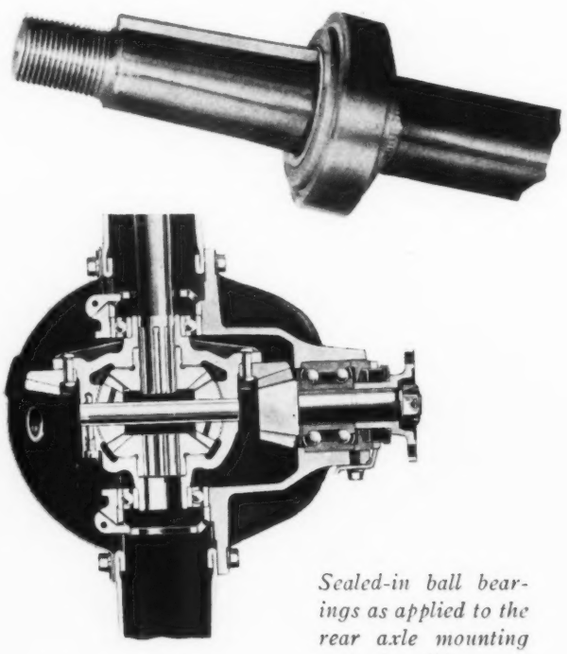
As might be expected, new or expected applications of oil filters parallels the application of central lubrication, with the exception of the classification including airplanes and engines where considerable attention is being given to oil filters. This can be partly explained by the fact that in former years the application of oil filters for industrial engines was largely considered a matter of extra equipment, whereas the present practice is to supply the oil filters as standard equipment on the machine as manufactured.

With an increase in the use of central lubrication, it is naturally to be expected that there should be a corresponding increase in the use of hose and tubing. It has been the experience of many engineers that the rigid type of tubing is not suitable in machines where severe vibration occurs. Since vibration leads to fatigue failure there has been a pronounced turn toward the use of flexible tubing, and as might be expected, this trend is most pronounced in the airplane and airplane engine industry. Here, 47 per cent of the manufacturers reporting in that field indicate that they have recently extended their use of flexible tubing, or expect to do so.

Next in line in extending the application of flexible tubing comes production machinery and equipment. An added reason for the use of flexible tubing, as given by the chief engineer of a screw machine manufacturer, is that, in addition to the other advantages, flexible tubing is preferable because of the ease with which it can be applied. It is no more difficult to attach than flexible wiring, and the saving in assembly costs largely make up for the increased cost of flexible over rigid type of tubing.

The use of flexible tubing and hose is also getting much attention from engine and pump designers, and designers of packaging machinery.

As reported by the J. N. Fauver Company, they have improved their synthetic oil-resisting tube so that it now handles oil at high temperature—approximately 180 deg.



Sealed-in ball bearings as applied to the rear axle mounting and the differential pinion mounting in the Oldsmobile

In the new design of Bausch & Lomb chair and stand for optical examinations, the instrument stand can be adjusted for height by means of a hydraulic piston

F. The wire jackets and yarn walls are placed on the tube by improved machinery resulting in tubes of greater flexibility and higher strength.

Increasing amount of attention being given to the proper sealing to keep out dirt and retain lubricants, is leading to increasing use of leather for seals, gaskets, and washers. Here again, as in the application of bearing seals, the field of construction and mining machinery and equipment heads the list with 45 per cent of the engineers having recently adopted or contemplating the adoption of leather for such purposes. Motors and speed reducers come second in applications of dust seals with 35 per cent indicating extended use.

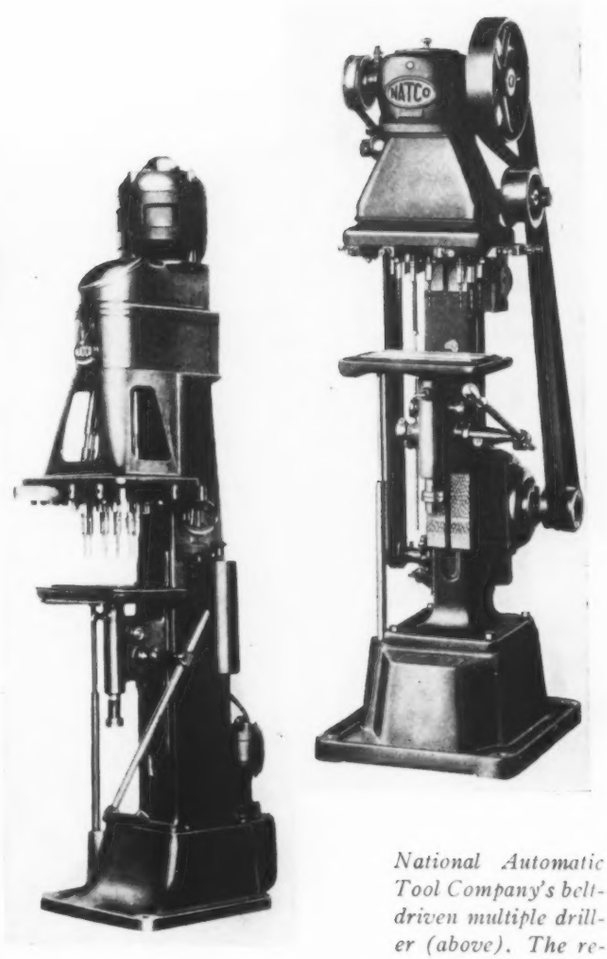
Electric Motor Drives and Controls

In extending applications of electrical drives, new types of motors—flange mounted, shaftless, solid end shield types, geared motors and motor reducers—have led to increasing use of individual drives with a corresponding increase in the use of magnetic controls. This trend is greatest, of course, in the design of heavy machinery, as shown in the accompanying tabulation.

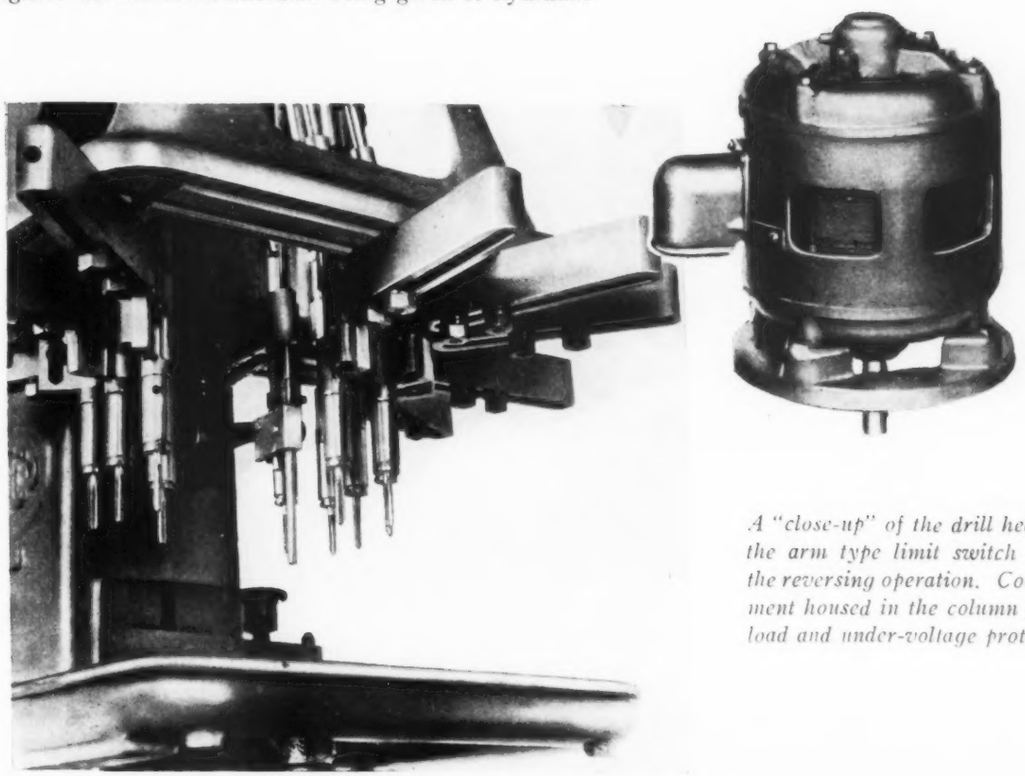
Trends in Motor Applications

FIELD OF MANUFACTURE	Electric Motors	Motor Reducers	Magnetic Controls
	(Per Cent of Group Reporting)		
Production Machinery.....	57	41	61
Textile Equipment.....	60	22	30
Packaging Machines	34	34	25
Construction Equipment.....	28	24	20

Among machine tool and production machinery designers the increased attention being given to hydraulic



National Automatic Tool Company's belt-driven multiple driller (above). The redesigned machine (left) is driven by the Louis Allis built-in reversing motor shown below, making a more compact machine



A "close-up" of the drill head showing the arm type limit switch controlling the reversing operation. Control equipment housed in the column gives overload and under-voltage protection

operation is shown by the fact that more than half of them report recent or expected adoption of hydraulic units this year, while last year only one-third were considering hydraulic operation. Pressure gages, regulating devices, electrically operated valves and pressure recorders show a similar increase.

Greater use of built-in motors, not only for main drives but also for multi-motor drives has naturally led to greater attention to automatic controls, limit switches and thermostatic devices. Electronic controls, a novelty last year, now have aroused considerable interest. The following table shows how designers of motor-driven machinery rate the importance of these various types of control devices.

Trends in Control Devices

FIELD OF MANUFACTURE	Limit Switches	Electronic Controls	Thermo-stats	Timing or Counting Devices
	(Per Cent of Group Reporting)			
Production Machinery	63	15	13	19
Textile Equipment....	27	36	18	36
Heating and Ventilating.....	16	–	52	8
Packaging Machines ..	9	18	9	–

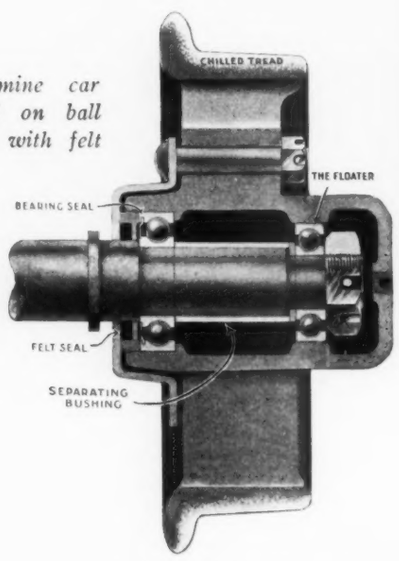
Effective use of improved motors and controls has also brought greater attention to efficient drives, leading to extended applications for variable speed drives, clutches, speed reducers, couplings, belt and chain drives. The accompanying brief tabulation is by no means complete but is representative of the current activity in the industries listed.

Motor Control Devices

It is not surprising that, as indicated in the accompanying table, designers of construction machinery are making such wide use of limit switches. Through this means, operation of the machine is made automatic. This is a natural corollary to the multi-motoring of the machines, and is often used to procure automatic cyclic operation.

Perhaps one of the most surprising facts relative to automatic control devices is the great amount of attention that is being given to electronic control for textile machinery. Apparently, twice as much attention is given to electronic control for textile machinery as is given to those devices for metal working machinery and packaging machines.

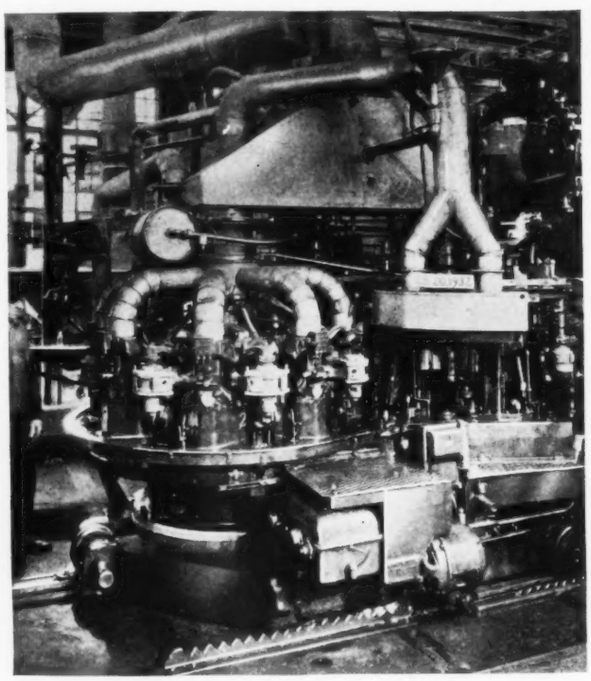
It has been reported that one of the difficulties in the way of applying photo-electric control to metal working machines for selective operation such as color sorting has been the problem of keeping the windows and lenses clean. Even a relatively thin film of dust will decrease the intensity of light beam to such an extent as to change appreciably the selectivity. Trouble has also been experienced because of the machine operator attempting to clean the glass with a greasy rag, which leaves a film of oil that is more objectionable than the film of dust removed. However, these difficulties do not exist with on-or-off operation with photo-electric tubes, nor do they exist when electronic control other than the photo-electric cell is used.



Sanford-Day mine car wheel, mounted on ball bearings sealed with felt

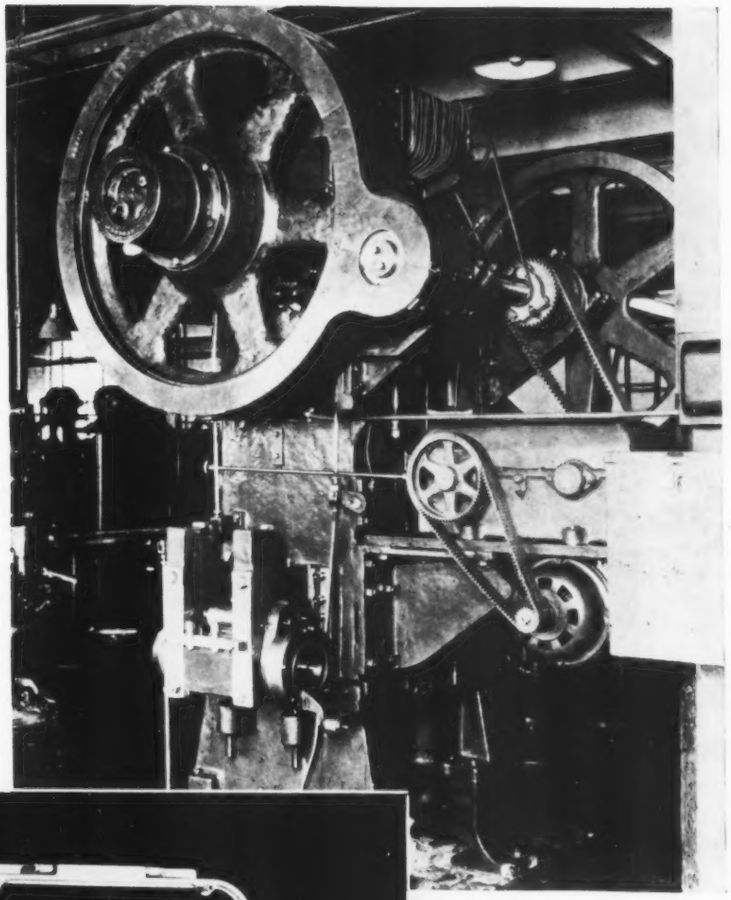
Monarch Lathe

In the Monarch automatic lathe is illustrated the extensive application of electric motors, automatic controls, limit switches and similar electrical devices, mag-

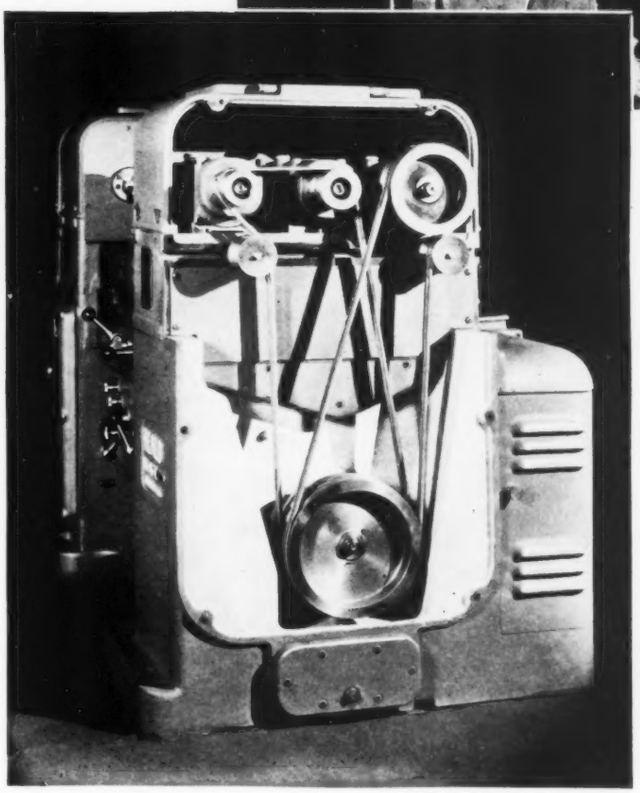


The Hartford 12-position bottle making machine is driven through a Link-Belt P.I.V. transmission so that the most desirable speed can be selected by the operator

This heavy-duty Bliss press is chain driven through a Link-Belt variable speed transmission. Central lubricating system is employed

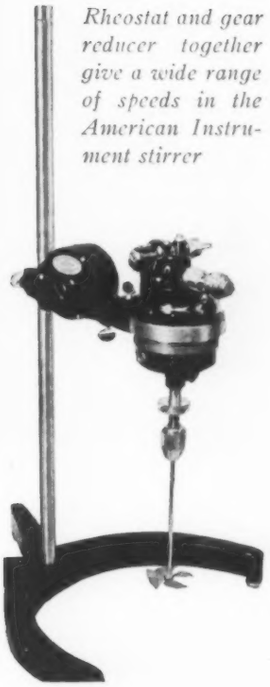


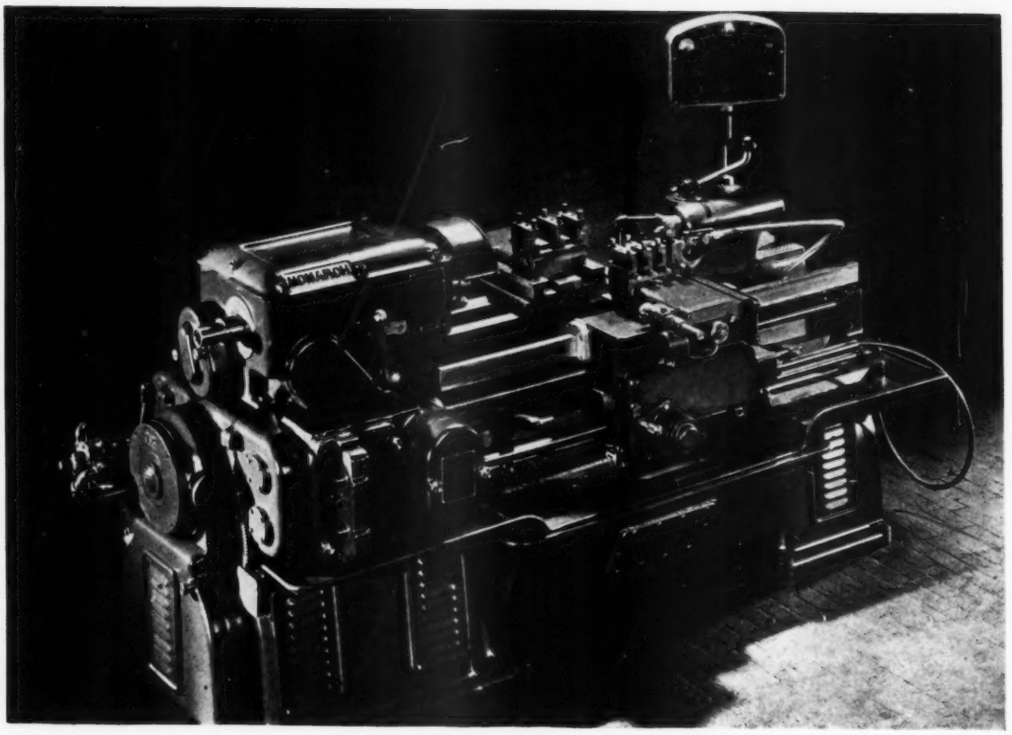
Sensitive tapping machine (above) designed by the R. C. Haskins Company is driven by a built-in motor using over-running clutches



Multiple V-belts and vibration dampeners under the main drive motor eliminate vibrations in the Heald precision boring machine. Rounded corners and hollow head cap screws give smooth surfaces and better appearance

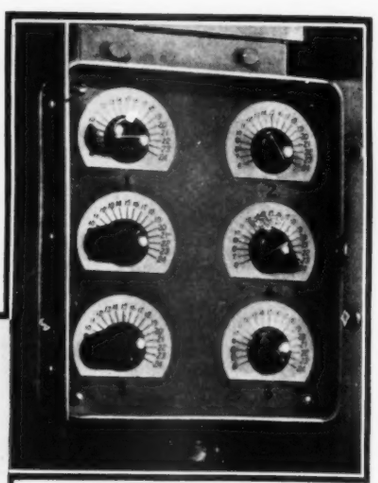
Rheostat and gear reducer together give a wide range of speeds in the American Instrument stirrer

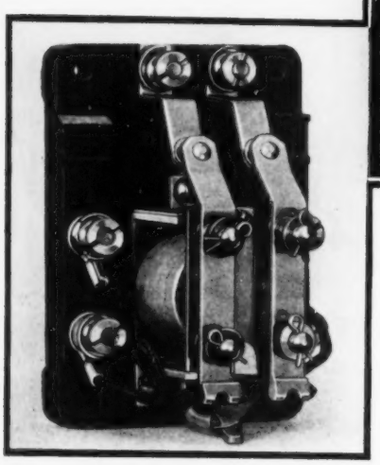


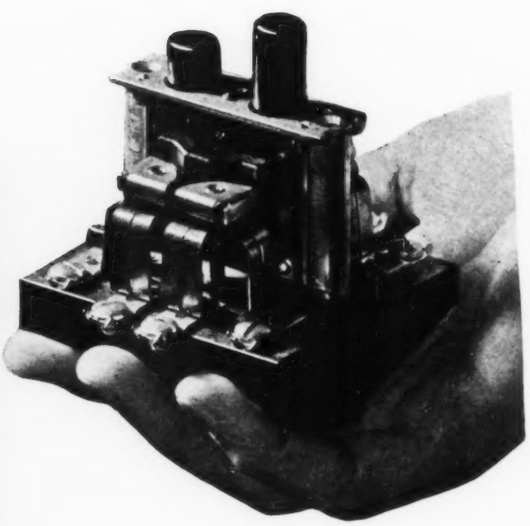


All Electric— Full Automatic

Latest in automatic lathes as conceived by Monarch Machine Tool Company. Six calibrated rheostats (right) give accurate feed setting for each diameter at which the tool cuts

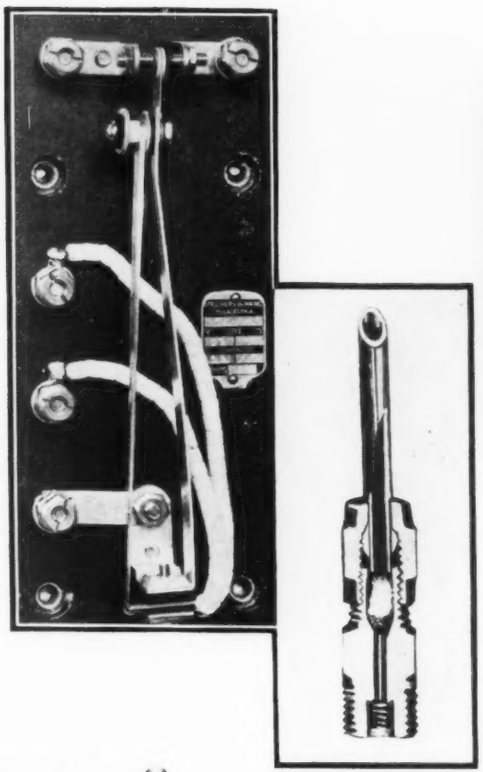


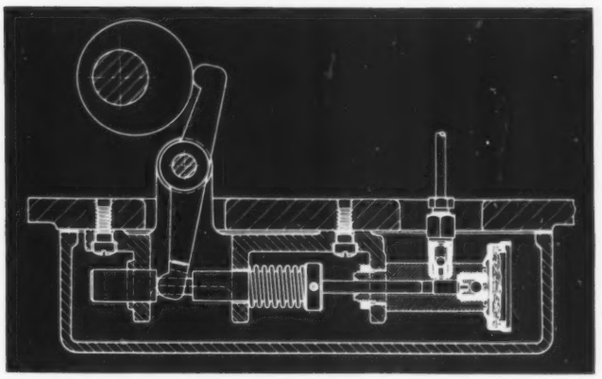




Heavy-duty Cutler-Hammer pushbutton switches mounted on the master control panel control the motors through magnetic starters, eliminating much high-voltage wiring

Stop dogs actuate precision limit switches that, through the Struthers Dunn relays shown here, control the Stearns magnetic clutches and magnetic clutch brakes which are located as shown on the drawing

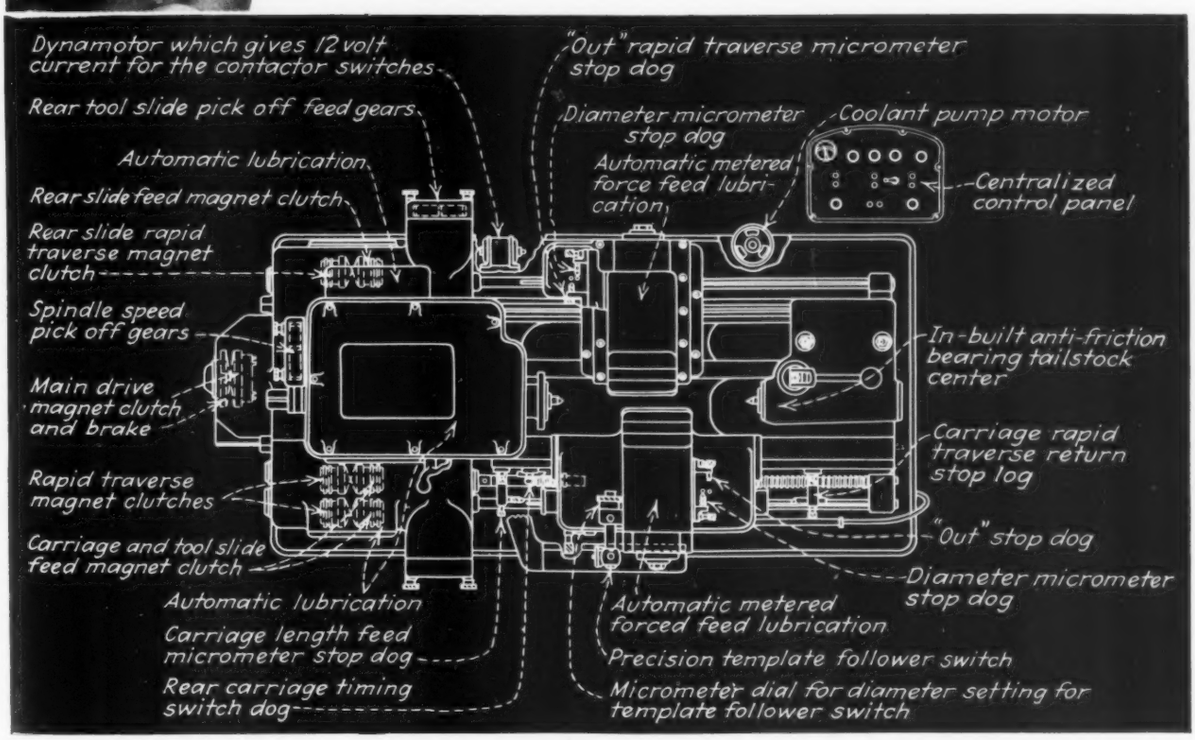


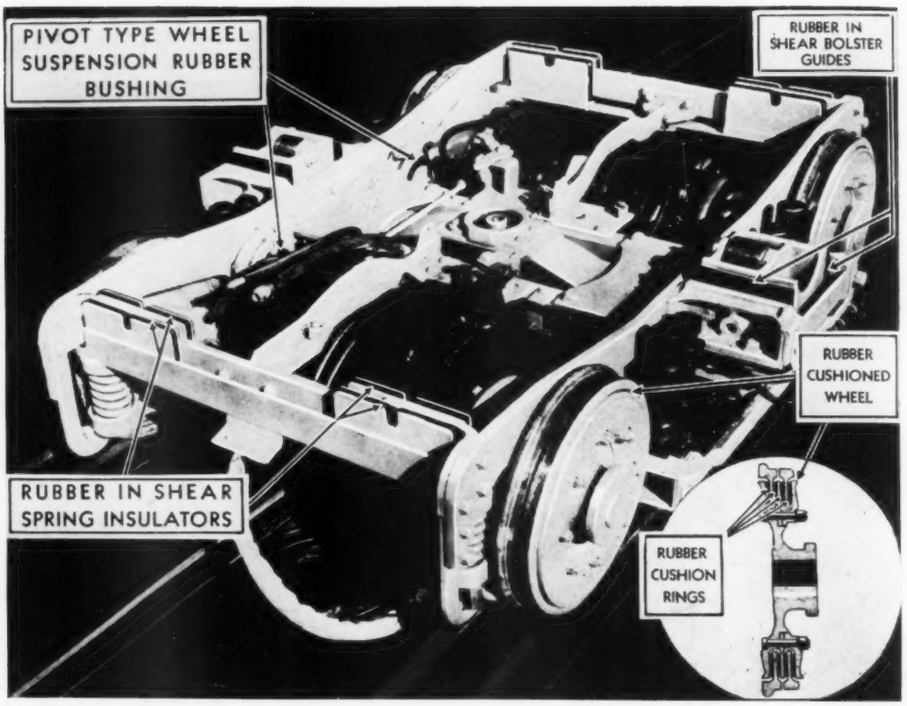


Automatic lubrication is provided by this Bijur lubricator, oil being fed to the bearings through Bijur drip plugs, shown to the left

One of the limit switches and (upper left) a Struthers Dunn time-delay relay for adjustable dwell at the end of any cut

Main drive is through a magnetic clutch-brake made by the Magnetic Manufacturing Company. The diagram below shows the location and function of this clutch and others that provide automatic feed and traverse


Dynamotor which gives 12 volt current for the contactor switches
Rear tool slide pick off feed gears
Automatic lubrication
Rear slide feed magnet clutch
Rear slide rapid traverse magnet clutch
Spindle speed pick off gears
Main drive magnet clutch and brake
Rapid traverse magnet clutches
Carriage and tool slide feed magnet clutch
Automatic lubrication
Carriage length feed micrometer stop dog
Rear carriage timing switch dog
"Out" rapid traverse micrometer stop dog
Diameter micrometer stop dog
Automatic metered force feed lubrication
Coolant pump motor
Centralized control panel
In-built anti-friction bearing tailstock center
Carriage rapid traverse return stop log
"Out" stop dog
Diameter micrometer stop dog
Automatic metered forced feed lubrication
Precision template follower switch
Micrometer dial for diameter setting for template follower switch


PIVOT TYPE WHEEL SUSPENSION RUBBER BUSHING
RUBBER IN SHEAR BOLSTER GUIDES
RUBBER CUSHIONED WHEEL
RUBBER IN SHEAR SPRING INSULATORS
RUBBER CUSHION RINGS

Latest design of street railway truck made by Brill makes extensive use of rubber in wheels, spring insulators, wheel suspension and bolster guides

netic clutches and automatic lubrication. The machine and some of the principal units are pictured on the two preceding pages.

The main driving motor, housed in the cabinet leg below the headstock, is mounted on a hinged plate to maintain proper tension in the V-belt drive. Through helical pick-off gears, 12 spindle speeds between the range of 41 and 610 r.p.m. can be obtained with normal motor speed. By changing the speed of the main driving motor, a spindle speed of 1,500 r.p.m. can be obtained.

Mounted on a bracket, the master control panel at the tailstock end of the machine gives complete electric control for both set-up and full automatic operation. Sensitive limit switches actuated by adjustable dogs, open and close relay circuits that control the motor and magnetic clutches through magnetic switches.

Limit switches and relays operate on 12 volts, the current being furnished by a small motor-generator mounted near the headstock. This eliminates most of the high-voltage wiring and avoids trouble that might arise from arcing at the contacts of the limit switches and relays.

Approximately 1 kw. 115 volt d.c. is required for the operation of all the magnetic clutches. The main clutch is an integral magnetic clutch-brake unit that gives instant stopping.

It was desired to provide an adjustable dwell for both tool slides at the finish of any cut when doing forming, taking the spring out of the work and other reasons. In order to obtain an automatic adjustable dwell, a small time-delay relay is used. By means of a screw at the relay contact, the delay can be varied from 0 to 30 sec.

Automatic force feed lubrication is provided for the carriages, bed ways, and tool slides. The headstock, and the front and rear quick-change gear boxes are also lubricated automatically. An oil pump, shown on page 425, circulates the oil from the reservoir in the headstock end of the lathe bed, the surplus oil furnished at the various points draining back to this reservoir.

Types of Drives

Comparing the returns with the reports received a year ago, a noticeable increase is found in the attention being given to short-center drives, universal joints, non-metallic gears and magnetic clutches. Recent or expected adoption of magnetic brakes, for example, is reported from more than 20 per cent of the production and textile machinery groups; more than 30 per cent of these two groups indicate interest in worm drives.

Greater activity is also apparent in the adoption of

Electric Motor Drives

FIELD OF MANUFACTURE	V-Belts	Chain Drives	Variable Speed Drives	Flexible Couplings	Speed Reducers
	(Per Cent of Group Reporting)				
Production Machinery..	40	24	33	26	22
Packaging Machines...	67	25	60	18	58
Dairy Equipment.....	57	42	40	56	40
Heating and Ventilating.	46	–	16	25	38
Construction Machinery..	40	56	28	8	24
Textile Equipment.	41	52	20	29	31

instruments of various types such as temperature recorders, tachometers, regulating devices and electrical instruments.

An investigation among designers of machine tools indicates that there is tremendous development in this field. These developments involve not only to electric motors, but also hydraulic drive and power transmission units in general. Quoting B. P. Graves, chief engineer and director of design for the Brown & Sharpe Manufacturing Company:

"On our high speed, universal, and plain, milling machines, we have given the drive considerable thought and study, endeavoring to eliminate all starting boxes and controls from the outside of the machine. We have been able to accomplish this in connection with the A.C. drives, and by doing so we have found it possible to eliminate the conventional friction drive to the machine. In one type of machine, a foot-type motor mounted in the base of the machine drives the main shaft by a silent chain with the sprocket being keyed securely to this shaft.

"We start and stop the motor by our standard starting lever controlled from the front of the machine. The start and stop button, and control unit as well, are mounted under the guard at the rear of the machine, making it possible to have all wiring and controls inside of the machine. By so locating them, we obtain a very short run of wire.

"The principal idea behind this design is to run the motor only when the machine is in operation. We have found this extremely beneficial and it is something that is taking very well with the trade.

"In our new light-type milling machine, we have gone a step farther and have made use of the NEMA flanged type motor, driving directly to the driving shaft by internal gear and pinion. This design eliminates the chain drive, motor mounting plate, and adjusting arrangement. The controls are the same as used on the high speed machines, both the wiring and controls being mounted under the guard and operated from the front by the conventional starting lever. Like the high speed machines, the motor runs only when the machine is in operation.

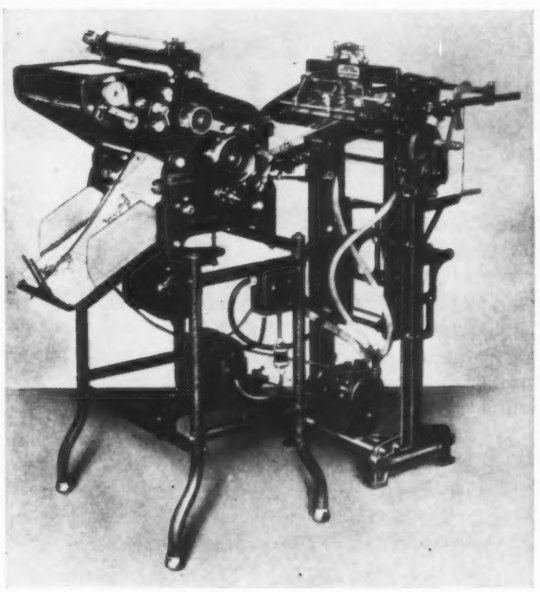
"In the vertical spindle milling machine two motors are used. The master motor being of a variable speed design, drives the cutter spindle, while the second motor, a single speed motor, is used for driving the feed. Both these motors are controlled from a central push button station but are so interlocked that if the master or spindle motor should stall for any reason, the feed motor is automatically tripped off, starting again just as soon as the load is released from the master motor. This machine, like the other two machines mentioned, has its control units and wiring all inclosed so that it presents a smooth and finished outline to the machine tool."

Multi-motoring of machine tools is one of the striking developments of the past two years.

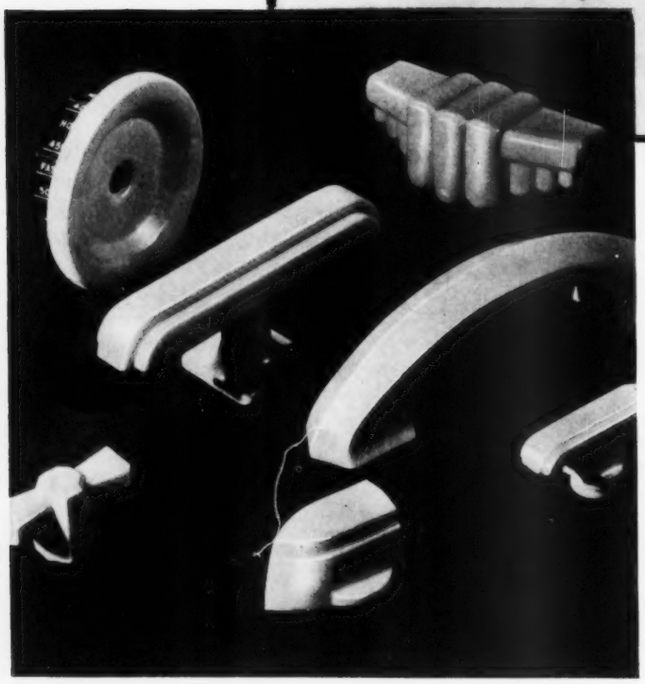
Noise Isolation

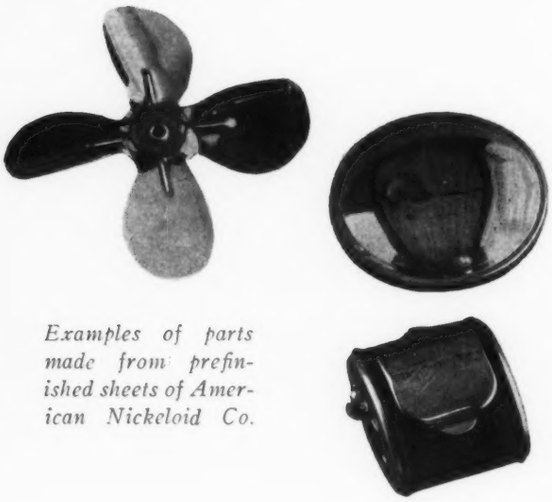
In this field, rubber is relied upon mostly while both cork and felt are used extensively. Rubber mountings for automotive engines continue to find favor. Sensi-

Rubber feet absorb vibration in the Royal typewriter — self-aligning Fafnir ball bearing pillow block is cork insulated— noise elimination is also a problem in business machines such as the Multigraph



These name plates, decorations and instruction plates are decalcomanias made by Commerford Co., Consolidated Lithograph Corp. and International Decalcomania Co. (Below) Plaskon parts for hardware and fittings, made by Toledo Synthetic Products, Inc.





Examples of parts made from prefinished sheets of American Nickeloid Co.

tive airplane instruments are mounted in rubber on their panels. Soft rubber is used for sealing joints in refrigerators. In the Royal Typewriter special attention was paid to noise isolation. For the feet of the typewriter, rubber suction pads were housed in pressed steel cups, the latter being insulated from the machine base by live rubber cushioning pads so that any machine noise is not transmitted to the desk.

The Synthane Corporation has developed a laminated bakelite and rubber sandwich for shock absorbing purposes in small motor and machine mountings. The Heald Machine Company use Firestone type vibration dampeners on their Bore-Matic machine.

The Sponge Rubber Products Company reports sponge rubber interior linings being used on typewriters and calculating machines. This type of rubber is also used for bus cushion fillers, arm rests, seat cushions, foot rests and anti-rattlers for windows.

Armstrong Cork & Insulation Company's Accopac is a new form of cork composition used for gaskets. It has four times the tensile strength of former gasket material, being made of a thin coarse fabric reinforcement, faced on both sides with cork. It is not laminated, but made of granulated cork, mixed with a binder, which is pressed top and bottom, bonding cork on cork through the interstices of the cloth.

Cork base for ship decks and for floors in railroad passengers cars, street cars and buses, is used for heat

insulating as well as vibration dampening, noise isolation, and the floor cushioning.

One of the increasing uses for felt is for the sound deadening of steel panels and thin metal walls. The die-cast magnesium alloy cover plate on the new Underwood typewriter uses for this purpose felt strip fastened with adhesive tape. Felt is used similarly in other business machines.

In the new design of Fafnir ball-bearing pillow block, a molded cork ring between the bearing and the housing serves to absorb shocks or vibrations.

Based on the total number of reporting machinery manufacturers, 34 per cent have adopted rubber for noise isolation or vibration damping, while 11 per cent are using cork and an equal number are using felt for these purposes.

Vibration Damping and Noise Elimination

FIELD OF MANUFACTURE	Vibration Damping			Noise Elimination		
	Rubber	Cork	Felt	Rubber	Cork	Felt
	(Per Cent of Group Reporting)					
Engines and Pumps.	18	8	3	13	10	10
Airplanes and Engines.....	30	–	12	6	6	27
Product Machinery.	8	3	2	13	3	2
Construction & Mining Machinery	24	–	–	4	4	–
Automotive Accessories.....	4	4	4	20	4	8
Locomotive Equipment.....	50	17	–	17	17	–
Packaging Machinery.....	13	7	–	7	7	–
Heating and Ventilating.....	8	–	–	16	4	16
Household & Office Equipment.....	10	10	5	33	15	20

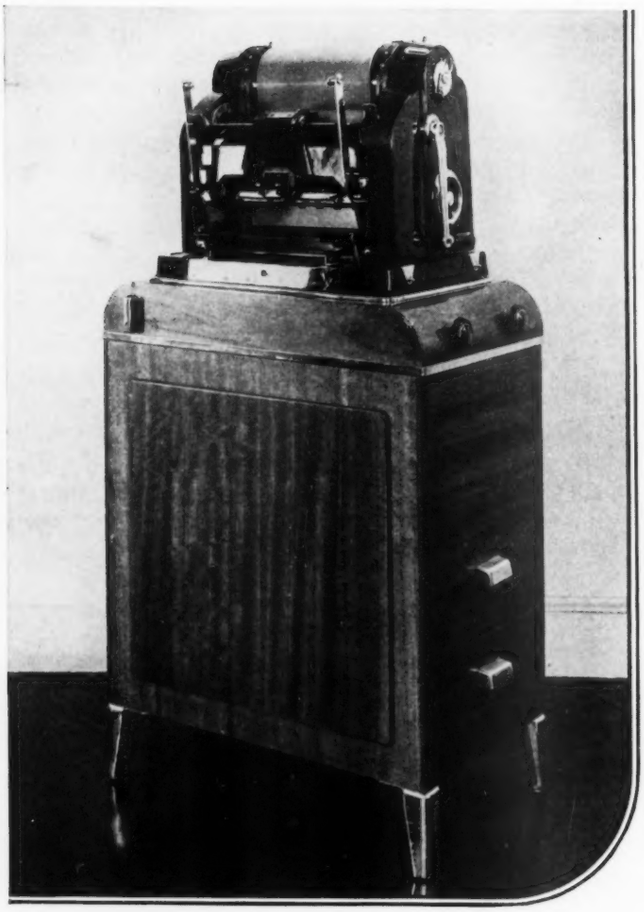
(Right) By a new process, laminated plastic sheets can have printing put on them, the printing forming an integral part imbedded in the sheet. (Below) Name plates can be etched, embossed, enamelled, or a combination thereof. Those shown here are products of the Fox Co. and L. F. Grammes & Sons

Hydraulic Operation

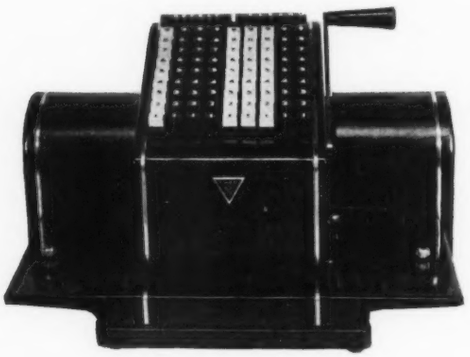
As might be expected, hydraulic operating units are finding further adoptions in construction and mining machinery, primarily for procuring straight line motion. The application of hydraulics for the operation of airplane controls, particularly landing gears, is well established. However, there is no indication of new hydraulic applications in textile machinery, agricultural machinery or packaging machinery.

Other Machine Devices

According to the tabulation, most attention to timing and counting devices is being given by designers of textile machinery, whereas designers of packaging machinery are apparently not giving this problem any attention. It is logical to assume that counting devices

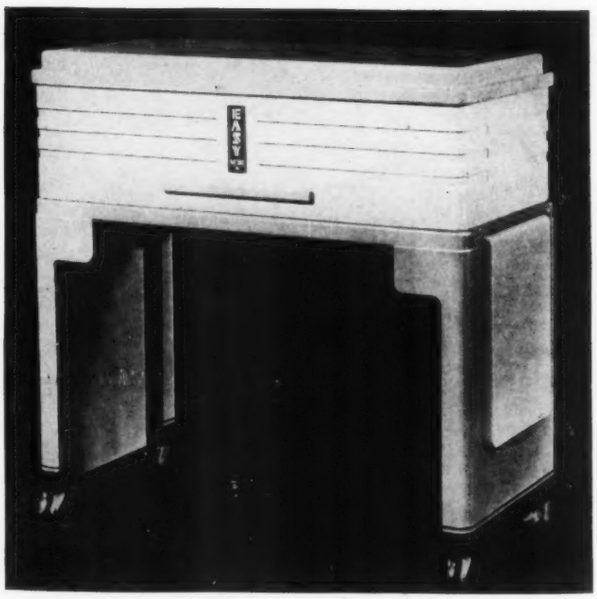


Todd checkwriter designed by Henry Dreyfuss for the Todd Company has smooth flowing lines



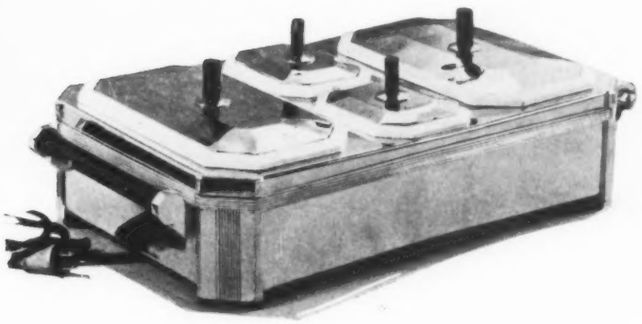
Examples of the Work of Industrial

(Above) Duplication machine re-designed by Raymond Loewy for D. Gestetner, Ltd., is fully inclosed and more compact than the previous design. (Left) Silver champagne cooler designed by George Switzer for the International Silver Company



Easy Ironer designed by Van Doren and Rideout for the Easy Washing Machine Corp. is fully inclosed with smooth surfaces easy to keep clean

Floyd-Wells gas range designed by Walter Teague is finished in green enamel and has bakelite molded handles. The Buffet Server shown below was designed by Lurelle Guild for Chase Brass & Copper Co. It is copper with chromium plating on nickel plating and molded plastic trim



al Designers

An example of the possibilities in the use of seamless steel tubing for furniture. This settee designed by G. Rohde for the Troy Sunshade Co. has a chromium-plated finish

Quick-drying lacquer developed by the Sherwin-Williams Paint Company reduces cost and production time in the manufacture of Philco radio cabinets. The cabinet shown here is Philco's latest design

are such a necessary item to all packaging machinery that it would be absurd for any designer of such machinery to consider for the first time, at this late date, the application of counters.

One interesting fact with reference to lighting has been disclosed by this survey. A special investigation was made to determine the extent to which engineers might be designing their machinery with built-in lighting fixtures. Only 20 instances were uncovered wherein the lighting equipment was designed as an integral part of the machine. But the significant part is that with the exception of four of these instances, all were new developments of the past three years and slightly less than half were developed within the last two years. One might conclude that this feature of mechanical design will be given more attention in the immediate future and that we are at the beginning of a new trend.

Adoptions of Paints and Finishes

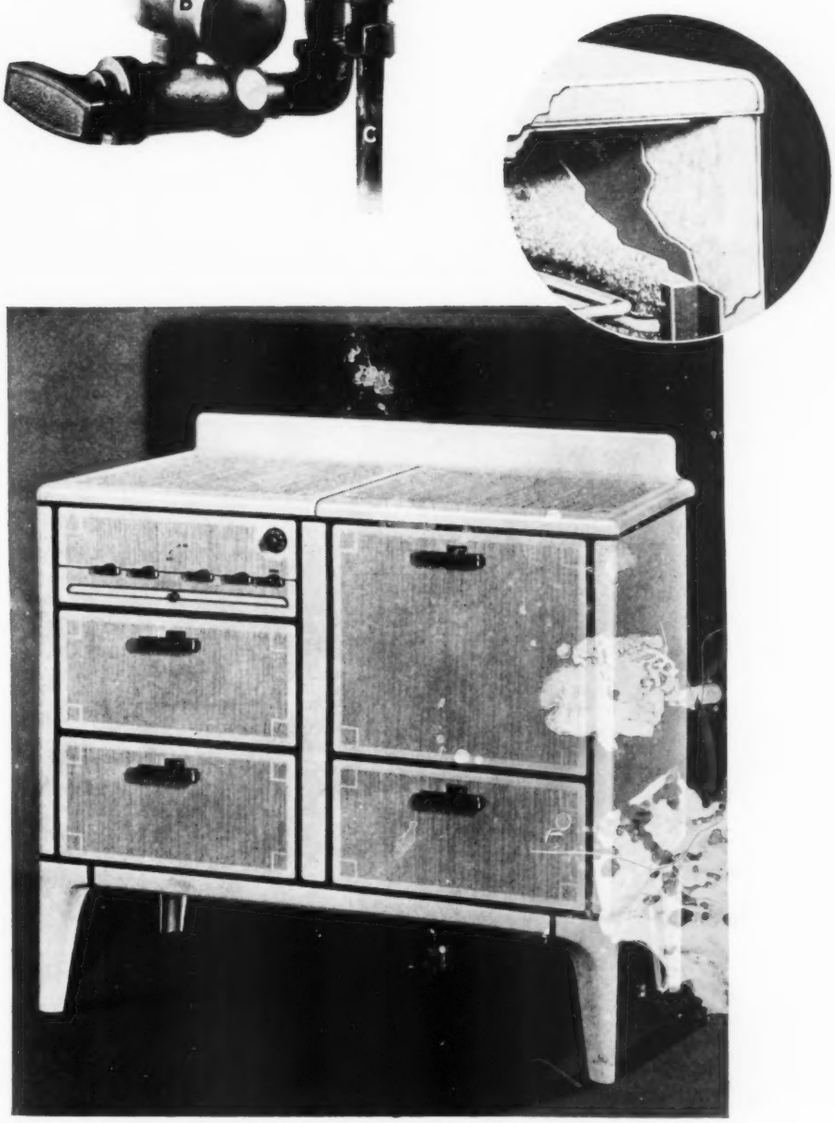
FIELD OF MANUFACTURE	Lacquers	Varnish	Japan Finish	Baked Porcelain	Name Plates	Decalcomanias
	(Per Cent of Companies Reporting)					
Household and Office Equipment	38	.....	24	10	43	29
Heating and Ventilating	48	8	16	20	28	32
Engines, Pumps and Valves	15	13	8	18	18	15
Production Machinery and Equipment	23	.....	2	.....	13	7
Instruments, Scales and Controls	33	5	5	14	38	29
Construction and Mining Equipment	21	10	.....	4	35	28
Motors, Speed Reducers and FlexibleCouplings	11	4	11	4	18	11

FIELD OF MANUFACTURE	Lacquers	Varnish	Japan Finish	Baked Porcelain	Name Plates	Decalcomanias
Textile Machinery.....	18	18	18	9	27	18
Packaging Machinery.....	33	7	.....	.....	27	13
Airplanes and Engines.....	59	24	.....	.....	41	18
Automotive Accessories.....	27	9	.....	.....	18	9
Total of all companies reporting.....	30	9	8	5	28	19

The finish with which a product is "dressed up" establishes to a great extent, its sales appeal. It is significant to note in the accompanying tables that cadmium plating leads lacquering and chromium plating, although for heating and ventilating and household and office equipment chromium plating is favored. This is readily understood, as the primary function of chromium for these appliances is to enhance appearance. As applied to the Royal typewriter, cadmium plate is used for rust proofing, and as a base for paint and plating.

In airplane and engine construction, and in heating and ventilating industries lacquers which withstand heat are largely used. One gasoline pump maker suggests that in lacquers, too much attention had been paid to quick drying at the expense of durability. After making extensive weathering tests on Japan varnishes and lacquers, they now use a synthetic varnish. They also state that they have been unable to obtain any chromium plating for die castings that stands up well. Another manufacturer of the same product states that if chrome-plated zinc die castings are not kept clean, these parts become subject to an electrolytic action which destroys the finish. However, cleaning with a plain or a mildly abrasive soap powder is said to prevent attack.

Capillary - type Robertshaw thermostat, improved insulation, sealed doors and porcelain enamel finish feature the new ranges made by the Standard Gas Equipment Company



Three hand rubbed and baked coats of Japan with a final coat of sprayed baked Japan are given Royal typewriter bases. Some business machines such as the Electromatic typewriter are crackle finished all over. Others have a combination of both, the crackle finish giving a panelling effect. While this finish is cheaper to apply it is said to overcome objectionable reflections.

Baked-on fused porcelain gives an attractive and durable finish. Heating and household equipment, such as gas and electric ranges and refrigerators use this finish. Porcelain enamel is finding a place as an architectural material, giving a life-time finish to pre-fabricated steel homes, stores and filling stations.

Pre-finished sheet materials having a plating of chromium or nickel on steel, copper, brass, aluminum and zinc are receiving wider use than heretofore. These sheets are made either with a polished finish, a satin finish, or a combination of both, in stripes or checker-board designs. This stock may be deep drawn.

Articles made from pre-finished sheet stock include ash trays, vases, toys, lamp and heater reflectors, gift and jewelry boxes, mirrors, mirror backed letters for neon signs, toasters and oven linings.

Summary of Trends

In a review such as this it is impossible to do full justice to all of the new design features that characterize the modern products. Self-tapping or drive screws, lock nuts and lock washers, and similar small parts have had a great influence on the design of products.

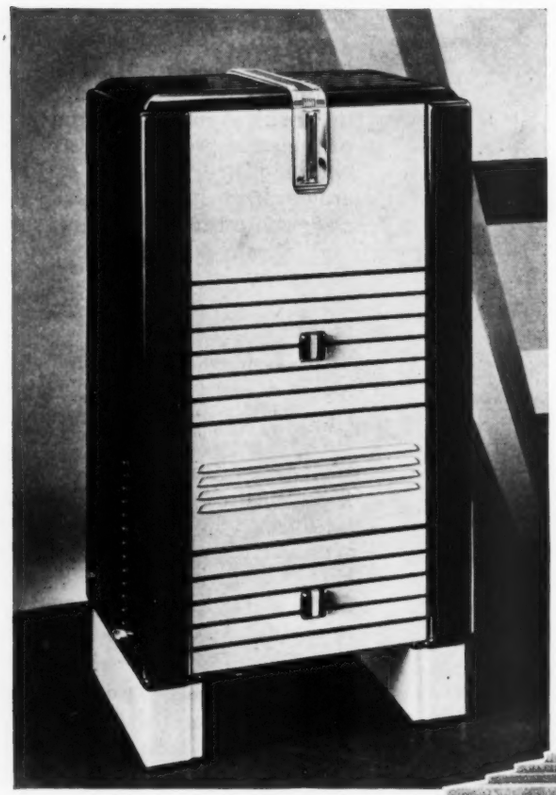
The development of a successful lock nut made feasible unit construction in airplanes. Various sections of the plane are made as units and then bolted together, using Elastic stop nuts, a type of construction that has received quite general acceptance in the aircraft industry, and has been adopted in automobile design.

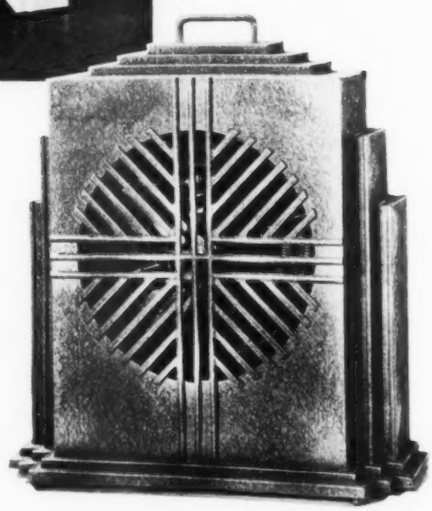
Similarly lock washers, old as they are, are still receiving attention, and for most products it is now considered essential to provide some means or other to prevent loosening of nuts.

Flexible shafting, recently adopted by 10 per cent of the manufacturers of production and packaging machinery and aircraft and automobile manufacturers, is rapidly finding new application. In construction machinery, 8 per cent report the recent or contemplated adoption of flexible shafting.

Plating and Finishes

FIELD OF MANUFACTURE	Chromium Plating	Cadmium Plating	Nickel Plating	Metal Spraying	Alumilite	Rust-Proofing
	(Per Cent of Companies Reporting)					
Household and Office Equipment.....	52	38	38	14	19	29
Heating and Ventilating....	52	44	16	12	4	28
Engines, Pumps and Valves...	30	28	13	20	13	13
Production Machinery and Equipment...	22	20	10	13	5	7
Sensitive Instruments, Scales and Controls.....	19	24	19	10	14	29
Construction and Mining Equipment...	.....	14	3	14	3	7
Motors, Speed Reducers and FlexibleCouplings.....	14	25	4	14	7	18
Textile Machinery.....	18	27	18	27	.....	9
Packaging Machinery.....	47	27	20	7	7	20
Airplanes and Engines.....	18	71	.....	18	18	30
Automotive Accessories.....	27	32	5	5	5	23
Total, of all Companies Reporting....	27	32	13	14	9	20





(Above) Porcelain enamel selected for permanent protection at service temperatures met by the Estate Stove. (Right) Burnished cast-iron motor bearings in the Thermador electric heater minimize effects of expansion

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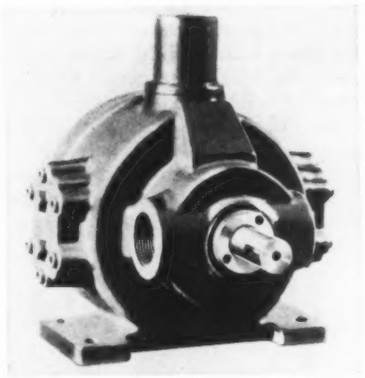
In these pages we have shown how engineers have achieved results that bespeak a true professional understanding in the solution of their problems. That the designers in one field of manufacture will profit from the experiences of those in another, is axiomatic. And thus it is that we extend to those who contributed to this presentation, our sincere thanks, in which, we feel sure, many of our readers will join us.

New Materials and Parts

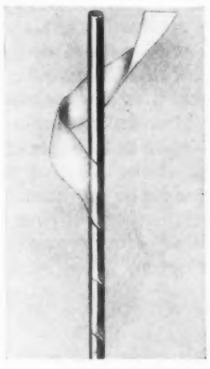
Hydraulic Pumps

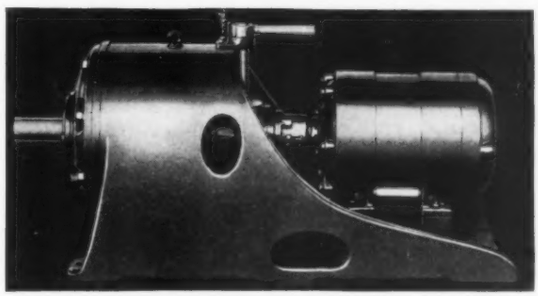
Variable volume type supplies constant pressure of 500 lb. per sq.in., with volume ranges from 0 to 2,000, 4,000 or 6,000 cu.in. per min. All sizes furnished in one size of pump case, variation in capacity being obtained by varying the width of pumping rotor. Pumps are multiple-vane type, having 13 vanes revolved at a constant motor speed of 1,200 r.p.m. Volume is controlled by offsetting governor ring or pumping chamber mechanically, positive control being provided through a control lever. Automatic control from a piston type of hydraulic governor reduces volume automatically to maintain any desired line pressure, eliminating by-passing of surplus oil and reducing power requirements. Rotor assembly carried on needle-roller bearings. Supplied individually or mounted on a base containing a supply of oil and providing space for direct-connected electric motor. Racine Tool & Machine Co., Racine, Wis.



Two-Speed Reducer

Incorporates both speed range and speed reduction in a single housing, using helical gears and anti-friction bearings throughout. High-speed gear in reducer carries two sets of teeth at different diameters which may be engaged selectively with either of two shiftable pinions. Two-speed design also available in triple reduction type. The Falk Corporation, Milwaukee, Wis.





Belden Celenamel

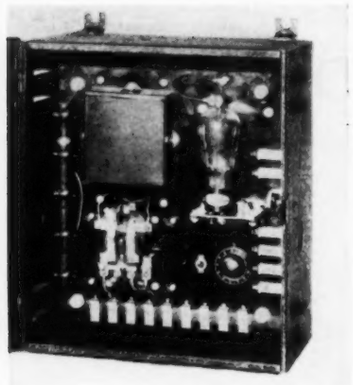
Is an enameled magnet wire insulated with strip cellulose wrapper wound over an adhesive applied to the wire. Wrapper is then lacquered and baked. Because of its greater dielectric strength, this magnet wire is said to save space, giving approximately the same space factor as silk enameled wire. In coils, this wire occupies approximately 64 per cent of the space required by double cotton-covered wire, and 80 per cent of single-cotton-covered enamel wire. Baked lacquer finish is said to protect enamel insulation against heat and varnish solvents. Belden Manufacturing Co., W. Van Buren St., Chicago, Ill.

Explosion-Resisting Valve Controller

Supplied with a single valve for liquids or gases as shown, or with two valves operated as a unit where fuel-air ratio must be maintained. Motor operated valve is designed to resist internal explosion caused by dangerous atmosphere imprisoned after opening the controller housing to make adjustment or to lubricate the equipment. Diagonal flange faces are machined and bolted together without a gasket so that flame from internal explosion will be dissipated and cooled as gases pass out between the machined faces. Automatic Temperature Control Co., Inc., Philadelphia, Pa.

High-Speed Controllers

Operating on the photo-electric principle, electronic industrial controls are designed to initiate a control function from an actuating impulse as brief as 1/5000 sec. Actuating impulse may be from a photo-tube, contact, control circuits, or sources where impulse is too small or too brief to directly actuate the usual type of relay. Being of the lock-in type, equipment will maintain the response for an adjustable length of time. Control illustrated uses one grid-controlled rectifier tube to operate a contactor or solenoid. For phototube operation, a rectox unit supplies d.c. power from any a.c. source. Maximum number of operations is 5,000 per min., operating from either a make or a break in the



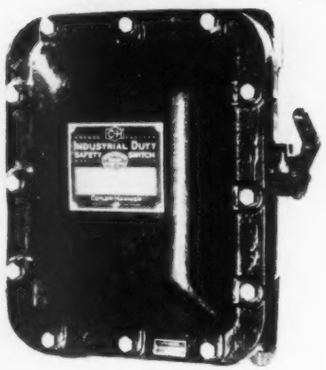
control circuit. Other controls with additional tubes for greater sensitivity and larger loads available. Higher power units supplied with time delay circuits for special sequence control operation. Each control comprises a panel assembly inclosed in a crinkle-finished cabinet with knockouts and terminals for electrical connections. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Drafting Machine

Embodying mechanical features claimed to save 25 to 40 per cent of drafting time, machine eliminates the use of T-square, triangles, scales and protractor. Clamps are provided to attach machine to the edge of drawing board. Protractor head revolving in a full circle is said to make every part of drafting board accessible. Five precision ball bearing assemblies, totally enclosed and lubricated for life, require no cleaning or lubricating. All cast parts are of heat-treated aluminum alloy. Available in two models. Charles Bruning Co., Inc., 102 Reade St., New York, N. Y.

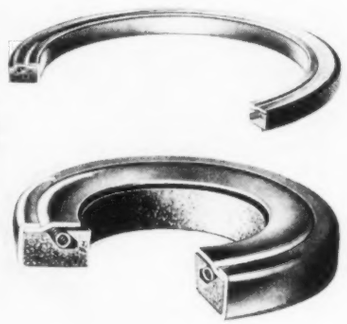
Explosion-Proof Safety Switch

For use in Class I, Group D, hazardous locations, switches include both single throw and double throw types in standard sizes up to 200 amp. capacity. Enclosure is weather-proof, with outside operating handle. Precision machined flange between case and cover is said to assure cooling of any flame which might occur from an explosion within the case. Corrosion resisting bolts hold the cover in place. Bottom of case has two pipe-threaded conduit holes. Handle may be padlocked, design accommodating three padlocks in either position. Cutler-Hammer, Inc., Milwaukee, Wis.



Bearing Seals

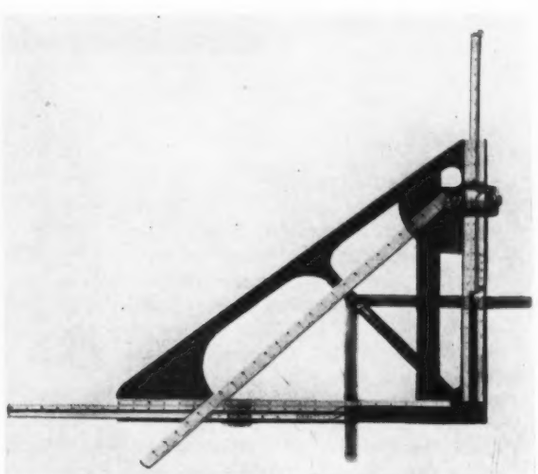
Available for normal sealing requirements, both inner and outer closures, for shafts from $\frac{1}{16}$ in. to 14 in. in diameter. With close outside tolerance, seals fit into a straight bored housing, requiring no closing plate or keys except where high unbalanced pressures exist. Outer case locks seal assembly, control washer determines position of leather seal, inner plate locates garter spring; sealing member made of various materials depending on temperature, speed, unbalanced pressures and chemical activity. Leather seals available for service up to 200 deg. F. and 3,000 ft.



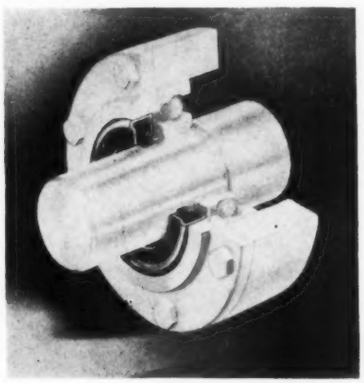
per min. Special materials and finishes available for more severe applications. National Motor Bearing Co., Inc., Oakland, Calif.

Trianalyst

Provides a direct means of solving numerical algebraic equations, giving with little or no incidental computation, the roots of quadratics, cubics and biquadratics, as well as the roots of certain other forms of still higher equations. Operation of instrument is based on the relations between a given right triangle and its inscribed square. One or more settings of the various parts are said to provide the solution for complicated formulas involving as many as 20 mathematical operations. Barrett R. Wellington, Troy, N. Y.



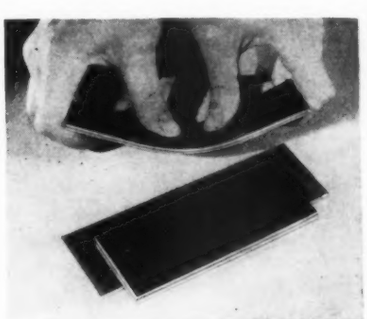
Garlock Oil Seal



Consists of a steel case flanged over an adapter ring bearing against a flexible spring member which spreads the V in the sealing ring. Composition used for the sealing ring is said to be non-porous, oil and heat resistant, having a low coefficient of friction. Ring is claimed to withstand any temperature encountered in oil seal service. Available in standard and special sizes to fit shafts from $\frac{3}{8}$ to 3 in. in diameter. The Garlock Packing Co., Palmyra, N. Y.

Rubber Laminated Bakelite

Alternate layers of Synthane and rubber of any thickness are bonded together to form a single piece, using any number of individual sheets. For gasket applications requiring a combination of resiliency, strength and rigidity or vibration-absorbing machine mountings. Also suitable for table top and furniture construction where quietness and resiliency are needed. Synthane Corp., Oaks, Pa.

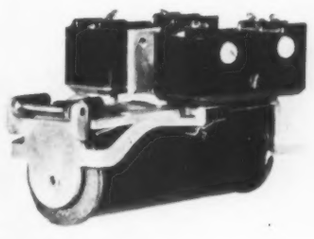


Boron Carbide

Said to be the hardest material ever produced by man. Available only in molded forms, the material is a form of carbon crystallized with boron. Claimed to be unaffected by the strongest acids and alkalis, and little affected by temperatures up to 1,000 deg. C. Has a compressive strength of 260,000 lb. per sq.in., and a coefficient of expansion approximately two thirds that of steel. For sand-blast nozzles, drawing dies, extruding dies, instrument bearings and thread guides in textile machinery. Norton Co., Worcester, Mass.

Micro-Switch Relay

For remote control purposes with d.c. control and a.c. load. Unit consists of a relay equipped with one or two micro-switches, giving fast, positive snap action with minimum motion of relay armature. Operation time is 0.002 to 0.010 sec.; release time 0.005 to 0.250 sec. Switch contacts rated at 10 amp., 110 volts a.c. Switches of make, break, or break-make type can be furnished. Base equipped with



studs for switchboard mounting. Automatic Electric Co., 1033 West Van Buren St., Chicago, Ill.

MANUFACTURERS' PUBLICATIONS

Electrical Control—Bull Dog Electric Products Co., Detroit, Mich. Catalog No. 34, 64 pages, "Bull Dog Electric Products," includes catalog information on safety switches, service equipment, distributing panels and cabinets.

Electronic Timers — Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Leaflet, two pages, "Electronic Contactor Timers for Spot Welding," giving application, operation and construction.

Speed Reducers—D. O. James Mfg. Co., Chicago, Ill. Catalog No. 137, 96 pages, 8½x11 in. "Continuous Tooth Herringbone Speed Reducers and Gears," presenting typical applications, ratings and catalog information on cut gears and speed reducers.

Speed Reducers — Universal Gear Corp., Indianapolis, Ind. Catalog No. 400, 84 pages, 8½x11 in. "Heliocentric and Geared Speed Reducers," briefly describing the construction, method of assembly, principles of operation and design of the heliocentric type as well as planetary and helical gear type. Catalog information includes ratios, speeds, torque and horsepower rating for each type.

Stainless Steel Wire Rope—American Steel & Wire Co., 208 South LaSalle St., Chicago, Ill. Booklet, 12 pages, "18-8 Stainless Steel Wire Rope, Cord and Strand," includes applications, types of construction and tables of breaking strength.

Strain Gage — Baldwin-Southwark Corp., Southwark Division, Philadelphia, Pa. Bulletin No. 72, four pages, "De Forest Scratch Recording Strain Gage," describes a new type of scratch extensometer, giving a record of strain variations.

Welding—The Lincoln Electric Co., Cleveland, Ohio. Well illustrated booklet, 12 pages, 8½x11 in., "The Shielded Arc," discusses physical properties, corrosion resistance, welding procedures.

V-Belt Drive—The Dayton Rubber Manufacturing Co., Dayton, Ohio. Catalog No. 160, 16 pages, 8½x11 in., "Dayton V-Flat Drives," lists advantages, describes construction, and includes table of design data as well as catalog information on belts and pulleys.

V-Belt Drive — The Gates Rubber Co., Denver, Colo. Bulletin DH-180, 20 pages, 8½x11, "Gates Vulco Rope Drives," describes the curved side wall construction, gives design information covering speed ratio, sheave diameters, belt speed, center distance, rating and service factors for multiple V, V-flat, quarter-turn and double-V drives.

"The Fiftieth Year," an 86-page booklet by the Harnischfeger Corp., Milwaukee, Wis., recounts their growth and expansion, pictures present plants, products and personnel.

"Masters of Metal" by the Scovill Manufacturing Co., 35 Mill St., Waterbury, Conn., is an attractively illustrated 18-page booklet relating the story of Scovill under headings: Custom Tailors to Industry, Raw Materials, Subsidiaries and Divisions. Photographs show products, processes and equipment.

"Twenty-Fifth Anniversary," a 16-page booklet prepared by the McGraw-Hill Book Co., 330 West 42d St., New York, N. Y., includes messages and historical facts, as well as pictures of officials, consulting editors and representatives.

BOOK REVIEWS

Die Castings

Herbert Chase. 256 pages, 6x9 in. Well illustrated. Black clothboard covers. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price $3.50.

Written specifically for designing engineers, this reference book shows typical die castings and products made from die castings in a chapter including more than 120 illustrations. Much of this information is presented in extended captions accompanying the illustrations.

Alloys for die castings are discussed, giving tables of physical properties, advantages and disadvantages of each material, including specific information on the most suitable alloy for a given application. Zinc, aluminum, copper, tin, lead and magnesium alloys are included.

In the last half of the book, die-casting design, alloy specifications and finishes are presented in terms of practical designs. Detail drawings for 30 die castings—mostly machine parts—are reproduced, including parts cast from all die-casting materials. In this section, particular attention is given to inserts, fillets, draft, ribbing, cored holes, gears and tolerances.

Tests and specifications for all standard alloys, and various types of plated and surface finishes, are given in detail. An index is included. Because of its practical and complete treatment, based on a variety of successful die-casting applications, the text is a valuable source of design information on die castings.

Unfallschutz an Pressen und Stanzen

(Accident Safeguards on Presses and Punches)

Dr.-Ing. Fritz Brauer, Gewerberat. 114 pages, 5¾x8½ in., 119 illustrations. Paper covers. Published by Carl Heymanns Verlag, Berlin, W.8, Germany. Price 8 Reich Marks.

Various phases of typical and specialized safety devices as applied to all types of presses and punching machines are shown and explained. The author has apparently made a canvass of that industry in Germany and portrays in the 119 illustrations numerous designs of safety devices. Although written in German, all machine designers may obtain from the illustrations alone, helpful suggestions relative to the design of automatic feeding devices, ejectors, safety clutches, guards, linkages for operating guards, foolproof operating mechanisms, both manually and electrically operated, safety lock bolts, safety couplings, one revolution mechanisms and rotating key clutches.

Eleven pages of introduction contain 9 statistical reports of press accidents followed by suggestions for greater safety. A bibliography listing 12 books and 15 articles is included.

Physical Constants

W. H. J. Childs. 77 pages, 4x7½ in. Clothboard covers. Published by E. P. Dutton & Co., Inc., 300 Fourth Ave., New York, N. Y. Price $1.20.

Fundamental units and constants given in the c.g.s. system in tabular and chart form are included for general physics, heat, light, magnetism and electricity. Although edited primarily for scientific use in typical British style, this small book contains many charts and tables of use to the designer.

Electron Tubes in Industry

Keith Henney. 490 pages, 6x9 in. 380 illustrations. Blue clothboard covers. Published by McGraw-Hill Book Co., Inc., 330 West 42d St., New York, N. Y. Price $5.

In describing the various tubes, their functions and typical applications, this reference book brings together from many sources complete information on a wide range of successful devices.

Fundamentals of electronic tube circuits as they differ from electrical circuits are covered in a 25-page introductory chapter without going into vacuum tube theory. Thermionic or heated-filament tubes are described and classified in the second chapter, giving for each type of tube its electrical characteristics, fundamental circuits and general uses.

The chapter on vacuum tube amplifiers opens with a discussion of the mechanism of amplification, and a lucid treatment of such terms as dynamic resistance and mutual conductance. Types of amplifiers and their particular fields of use are given, using circuit diagrams and electrical constants taken from actual applications. More than half of this 90-page section is devoted to the description of instruments, mechanisms and electrical devices using amplifiers.

Similar treatment is given ionized-gas tubes in a chapter of 130 pages on gaseous triodes, devoting, for example, 12 pages on the design of electronic welding timers. Two chapters on light-sensitive tubes, covering more than 150 pages, include types, characteristics and circuits for all commercial photocells. Type of applications, what cell to select, associated amplifying equipment, photometric units and light sources are discussed from a design point of view, using actual applications as examples. Most of the chapter, however, is devoted to a critical discussion of the use of photocells in devices such as automatic sorting and inspecting machines, register controls, synchronizing devices and automatic temperature controls.

A chapter on miscellaneous tubes and circuits, an author index and a subject index complete the text.

Throughout the book, references to current technical literature are given at the bottom of each page, while a bibliography at the end of each chapter includes texts and reference books.

Mechanical Vibrations

J. P. Den Hartog. 386 pages, 6x9 in., illustrated. Blue clothboard covers. Published by McGraw-Hill Book Co., Inc., 330 W. 42d St., New York, N. Y.

A proper presentation of the subject of vibrations would be impossible without involving calculus and differential equations. Hence a good command of calculus and an understanding of differential equations is necessary for anyone to understand this text.

Though written primarily to be used as a text book, and based on lecture notes, the author has not lost sight of the needs of practicing engineers in the presentation of his subject. Extensive use is made of graphical presentations, and practical applications. Three chapters are devoted to multi-cylinder engines, rotating machinery and specific vibration problems as they relate to engines, governors, airplanes and similar machinery. And throughout the whole text, reference is made to vibration problems as they occur in industry. Automobile shock absorbers, torsional vibrations, gyroscopes, motor supports and similar applications of the subject of vibrations are presented.

A bibliography of the most important books and articles is also given.

Cantilever Spring Design

R. L. PEEK, JR.
Bell Telephone Laboratories, Inc.

ALTHOUGH the final design of small cantilever springs must be based on experience with actual assemblies, the chart shown on the following page is useful in obtaining a preliminary design, and in determining permissible modifications in a previous design. This chart solves the usual cantilever spring formulas, the results obtained being as reliable and subject to the same limitations as the formulas themselves. The relations assume, for example, that the springs are rigidly clamped, which is seldom true, particularly when the cantilever springs are used for electrical contacts clamped between strips of insulating material.

Being of the set square type, the chart solves an equation in four variables at a single setting. Since the two index lines are at right angles to each other a straight edge and a right angle triangle are needed. The straight edge can be set on two scales, and the triangle held against it so that the side perpendicular to the straight edge intersects the other two scales. The scale readings intersected by the two perpendicular index lines satisfy the design equation.

Relations between maximum fiber stress and deflection involve the elastic modulus, and a separate chart is therefore required for each material. Two charts can be combined in one by giving separate scales for each material, as in the chart on the next page. The values of elastic modulus used are based on experience data, using a maximum value so that the fiber stress obtained is a maximum for the material.

For practical purposes, this chart may be applied to cantilever springs that are slightly bent, provided the length is taken as the perpendicular distance from the line of load application to the plane of clamping. The deflection given is that of the point of load application. Dimensions for the thickness are given both in inches and in B&S gages.

Shown on the chart is a small diagram indicating the procedure for the use of the chart. The computation for determining maximum fiber stress is as follows:

Set length L and deflection D on one straight edge, then setting any perpendicular straight edge on the spring thickness h, the maximum fiber stress f may be read on this same straight edge. Or if D and L are fixed by design considerations, the second straight edge may be shifted to coincide with the specified safe fiber stress f, and the corresponding thickness h read in the same way. Or if thickness h and fiber stress f are fixed, one straight edge may be set on the scales for these quantities, and a perpendicular straight edge shifted to read the length L which will give D the required deflection.

Both straight edges may be shifted to determine what possible combinations of thickness and length will give a desired deflection without exceeding a specified fiber stress. In every case it is essential that the D and L scales be read on one straight edge, and the h and f scales read on the other straight edge, which must be perpendicular to the first.

Additional charts for cantilever springs will appear in a later number. Whereas the accompanying chart gives relations between stress and deflection, the additional charts will show relations between load and deflection, and load and stress.

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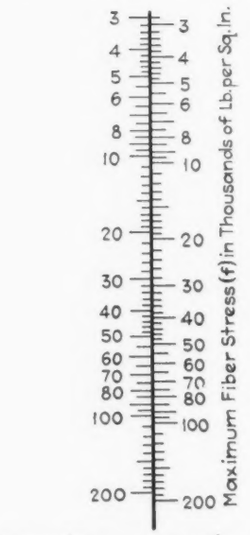
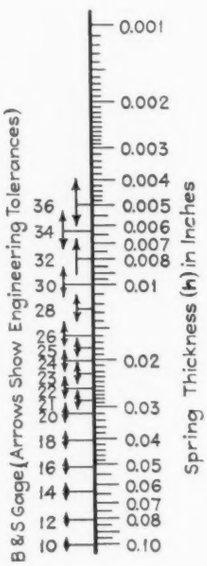
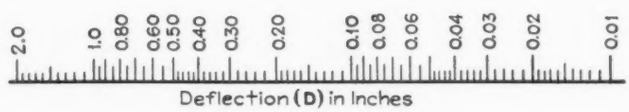
Cantilever Spring Design

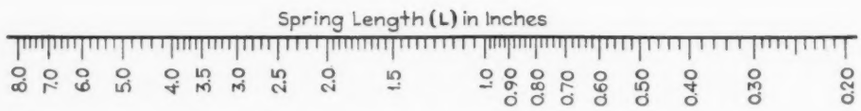
R. L. PEEK, JR.
Bell Telephone Laboratories, Inc.





Values of **h** and **f** cut by one edge **(AC)** of right angled triangle, with values of **D** and **L** cut by other edge **(AB)** satisfy equation for maximum fiber stress: $f = \frac{3EDh}{2L^2}$





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